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Compiled for the assistance of engineers confronted with specific design problems

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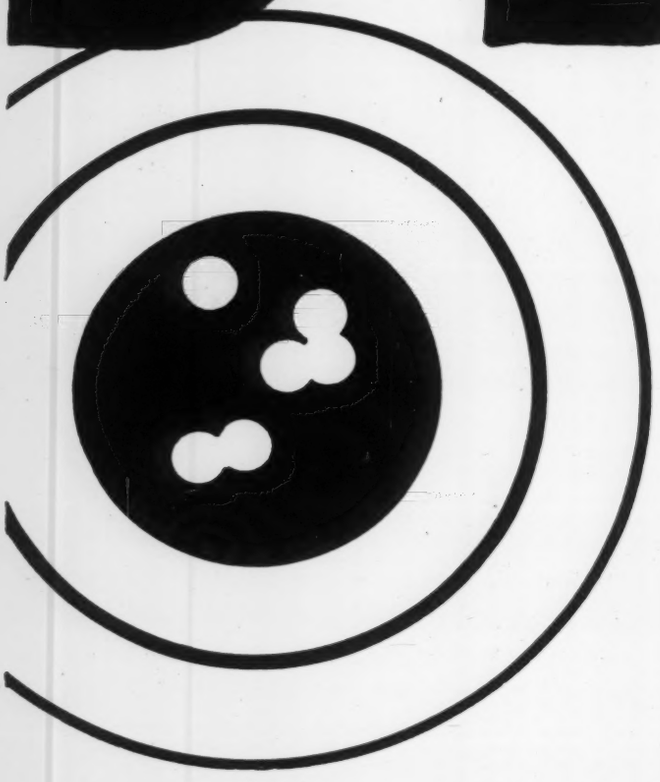
WHEN a manufacturer of printing presses brings out a new design—one in which the designer has departed from existing practice—it is certain that the new press embodies features of interest not only to other manufacturers of printing presses, but also to builders of washing machines, packaging machines and scores of other types . . . The reason for this is that similar basic principles, materials and parts are used—all machines being fundamentally the same . . . MACHINE DESIGN serves the engineer in charge of design by describing—as one of its primary functions—the features embodied in specific and up-to-date machines—selecting those features of common interest which may be considered for application in the design of other types of machinery.

DEFI



WHAT IS A MACHINE?

Expressed in its simplest terms, a device for applying or modifying force to a specific purpose is a machine. A few simple laws of mechanics are the basis for every machine built. All machines are made up of the same basic materials, incorporate the same basic parts. Hence there is a common interest between men who design machines, no matter for what purpose.

WHAT IS DESIGN?

The design of machines connotes the practical application of the mechanics of machinery, the drawing of plans, and the consideration of design on sales, as well. And, above all, it implies a thorough knowledge of materials and parts, and particularly close familiarity with the sources from which they can be obtained.

MACHINE

MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

December, 1932 Vol. 4—No. 12

Considering Design from the Production Standpoint

By Harold F. Shepherd

Part I—Founding

TOO often the engineer designs his parts without due consideration of production. With this article, MACHINE DESIGN begins a series planned to remind designers of methods to reduce costs and produce better designs by more careful consideration of manufacturing facilities and their application.

DESPITE the fact that in founding the designer has available a technique so flexible that it can be employed to produce anything from a sash weight to an equestrian statue, superior craftsmanship in pattern shop and foundry should be called upon even more sparingly than in the machine shop. However, the engineer who designs a new machine rarely tries to visualize the difficulties involved in the production of his design by the patternmaker and founder.

This is a machine age even for the patternmaker. He, like the machinist, wishes to employ machine work in preference to hand work and such work is considerably cheaper. Consequently, if patterns are to be built at a minimum cost castings must be designed for machine pattern work just as they are designed for machine finishing. Patterns to designs evolved from this practical viewpoint usually are adapted better to foundry production than those of more imaginative form.

Fig. 1 shows an example of this studied simplicity. Except for the filleting and finishing and the separate pads, this pattern was built up of machine cut scantlings, cants and staves.

Not all castings serve such few and direct functions as an engine bed. Fig. 4 shows a cast steel diesel - electric locomotive frame with provisions for engines, generators, draw bars, trucks, brake equipment; in fact the backbone of a locomotive. Because it would require a great many cores, however cast, this class of work is made by a special technique evolved by the foundry that produces it. A simple mold is swept out to receive the numerous cores which themselves confine the molten metal to the shape of the casting. Strict-

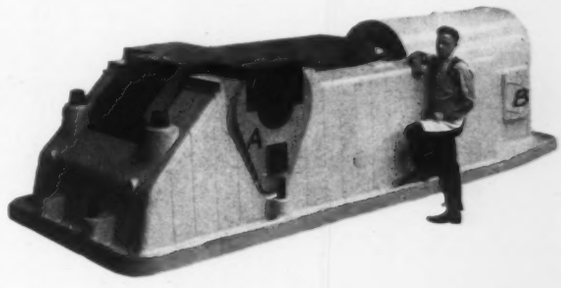


Fig. 1—Parts designed for simplicity of line permit patterns of machine cut scantlings, cants and staves

ly speaking, the mold proper is one great core print.

But castings cannot be designed from the patternmaking angle alone. While a good molder will produce a casting from any pattern that can be removed from the sand by some less drastic process than burning out, or make mold and cores with a few simple sweeps and forms, most production founding must be carried out with the aid of a large percentage of semi-skilled labor. Even when artisans are employed, the finest and cheapest castings are produced from designs which give evidence of being formed not only for function but for foundry production.

Should Recognize Parting Lines

Every normal pattern is constructed for draft from a conventional two part mold and every designer should be able to scan his drawing and recognize the natural or possible parting lines of pattern, mold and core boxes.

This much established, overhang and back draft may be detected and corrected wherever possible. Openings, serving to locate and support cores as well as to give vent to the gases liberated when pouring, may be placed in proper relation to the mold joint, with due consideration of the necessity for removing the reinforcing wires, rods and arbors along with the core sand when cleaning the finished casting.

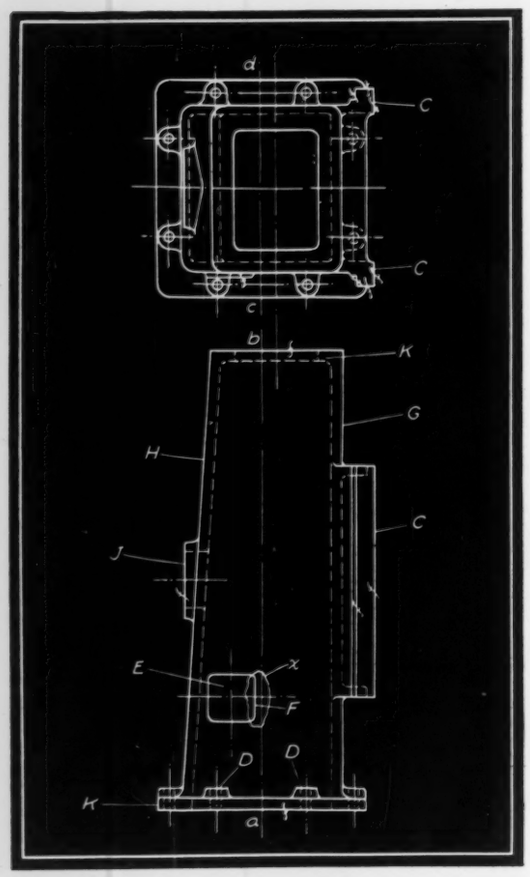


Fig. 2—Typical machine column design discloses points where production could be made easier

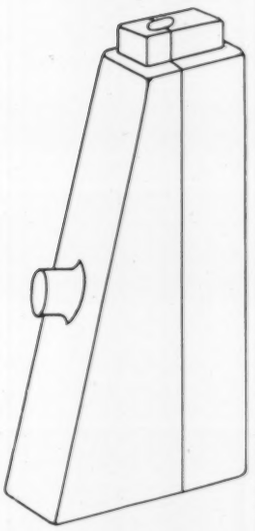


Fig. 3—When difficulty is encountered in visualizing the core required for a design it is wise to sketch it roughly. This sketch is of the core which would be required for the casting shown in Fig. 2

Fig. 2 shows a machine column serving as a specific example of some of the objections that may be offered to a design by the patternmaker if not foreseen by the engineer in charge. This column conforms in general appearance to common practice, yet much can be done to improve it from the production viewpoint. Although it might be produced otherwise the average foundryman would prefer to cast it on the side with the ways *C* at the bottom of the mold to insure a dense clean surface after finishing. The pattern would be split along the plane in which lie lines *ab* and *cd*. The first foundry operation is indicated in section by Fig. 5. The lower half of the pattern is inverted on a follow board with the drag half of the flask surrounding it. Sand will be rammed about the half pattern until the flask is filled. Next the sand surface is struck off, the bottom board bedded and clamped on and the job rolled over to receive the other half of the pattern and the cope or top section of the flask for final ramming up.

These operations completed, the upper half of the flask is lifted off and inverted. Both halves of the pattern are drawn, gates for the admission of molten iron are cut, and the mold dried and finished with a suitable coating. Finally, the cores are set and the mold is closed, clamped and weighted for pouring.

Ways Prevent Drawing of Pattern

Checking the effect of this design on the founding in more detail, Fig. 5 shows that the ways *C* protrude so as to prevent drawing of the pattern. These parts may be made loose and skewered or dovetailed in place so as to remain behind when the pattern is drawn, after which they can be drawn laterally into the mold. The pad *A*, Fig. 1, is dovetailed in this way while the pad *B* is skewered.

An argument against loose lateral projections

on a pattern which the designer should bear in mind, is that the tucking and bedding of pattern parts, once practiced, are not permissible in modern machine foundry practice.

The flask and pattern is set on the platen of a jolter or jarring machine. Sand is shoveled in or delivered from a chute, and the machine compacts it by raising the job and dropping it violently. Or sand is delivered to the flask in a penetrating shower by the centrifugal machine known as the sand slinger which rams by impact. Small or snap molds are rammed by hydraulic, pneumatic or lever presses if not by jolting the mold. These machines are used for a wide variety of work since in a measure they replace the care and judgment required for hand ramming the mold although some pean ramming about the draftless sides of common flasks still may be practiced.

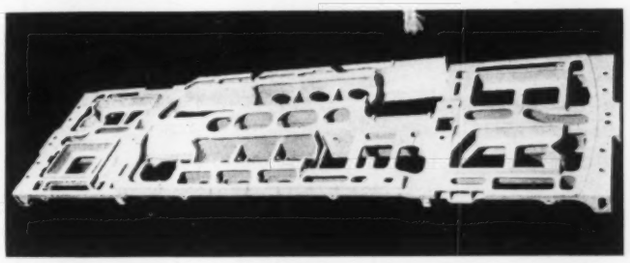


Fig. 4—A special technique is required to make many intricate castings such as this locomotive frame

Sand cannot be squeezed nor jarred compactly except in the line of motion, nor can it be flung from above to fill under overhanging ledges. Voids are left as in Fig. 5 at *N* unless what should be truly a machine process is supplemented by hand labor.

Scars Mark Fin Location

Cores as at *O*, Fig. 5, sometimes are used to overcome the difficulties introduced into machine molding by draft and overhang; but the result of this practice is a casting with two qualities of surface on the same plane, one showing the imprint of the core, the other that of the mold. The sands and washes used for the two are different, each being suitable to its purpose. Furthermore, scars are bound to mark the location of the fin due to molten iron finding its way into the junction between core and mold. Doubtless the ways, *C*, Fig. 2, could be brought within the main casting contour without impairing the machine, in fact the relation of length to breadth of saddle might be improved thereby.

There are other faults in this design of much the same nature. Lugs *D*, Fig. 2, will not draw except inwardly and must be made loose on the pattern unless backed up by a core print extending to the plane of parting. The side lugs could be omitted or, if required, a single bolt on the center line might serve as well. Pad *E* also will not draw except inwardly. If it may not be moved bodily so that its edge *F* coincides with the casting center line which is the mold parting line, it might be extended that far and the companion flange made to fit. If this is not done the little body of sand located in area *x* may carry away when closing or pouring and deposit somewhere else in the mold since it is only a bridge between pad and parting.

Halves May Not Register

Next, the core may be considered. It most likely will be made in two halves, the joint being along the plane *ab—cd*. If these two halves were symmetrical one half core box would serve for the job. Unfortunately they are not. Side *G* is plumb and side *H* slopes so the halves will not register when superimposed. If the column were made in parallel or obelisk form it would have the same cantilever strength and be a symmetrical core but for one other feature—the opening *J*. Openings could be made on both sides, serving several valuable purposes. Besides halving core box cost and storage bulk the core would be anchored against sag due to its own weight as well as against floating in molten iron or at least bowing under buoyant stress. Prints are always preferable to chaplets, especially for oil or pressure vessels where the latter so often introduce leaks. The pad about the opening notably provides aligned support for the machining operation on ways *C*.

Loose pieces in core boxes sometimes cannot be avoided by design changes. Coremaking usually involves attentive direction, and little machine work is possible in that branch of the industry. Much can be done, however, to simplify core boxes by redesign of the part, and if this is done consistently the making of cores on molding machines may be advanced. When difficult to visualize, it sometimes is wise to sketch

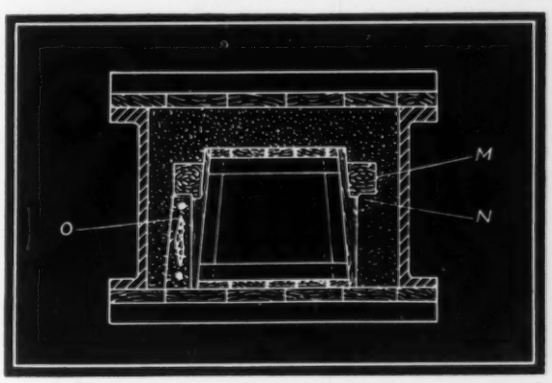


Fig. 5—Cross section of first foundry operation indicates points of difficulty in casting

the cores required for a casting as Fig. 3 serving for Fig. 2.

Frequently castings are better for the removal of a lot of internal stiffening since such ribs are prone to fracture by reason of late cooling while restrained by outer walls which have set previously.

The exact amount of shrinkage in a casting cannot be estimated accurately. Long castings frequently shrink much less than expected and as a consequence end flanges *K*, Fig. 2 carrying important stresses, show less than the drawing thickness when the casting is finished to the specified length. It is a good plan to dimension such flanges at least 1/16-inch to the foot of casting length thicker than actually required.

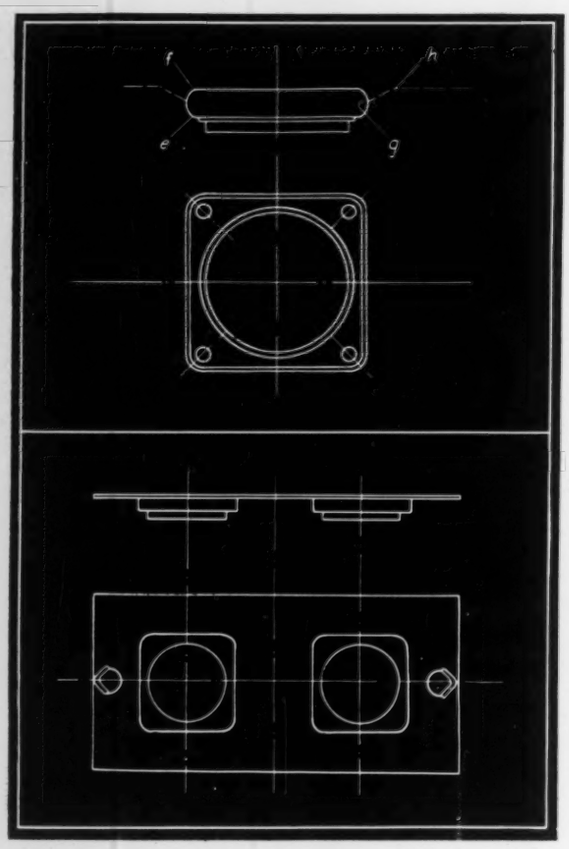


Fig. 6—The pleasing line shown in the top view increases cost while redesign, below, speeds production

The height of pads also requires consideration. Molten iron standing in pouring heads, gates and risers exerts a terrific bursting stress on the flask and unless the heaviest type of flask equipment is used or the job rammed into the floor some strain takes place thickening casting walls. Thus the layout man may locate the machine dimension of a pad like *E*, Fig. 2 below the general surface of the casting. In this too common event the surface will require profiling out with a small milling cutter or unsightly chipping for planer tool clearance. Pads should be of ample elevation. If made of a height equal to the general casting thickness they should be about right.

The matching of casting pads and faces with the companion parts has a serious influence on the appearance of the finished product. Only the finest machine molded castings made from accurate metal patterns may be expected to match. In designing heavy machinery the accepted principle is to avoid the need of register.

When in doubt as to the "art value" of some line in a design a decision may be reached by considering what influence this line will have on the cost of patterns or castings. Thus Fig. 6 (top) is a cover plate for a pump valve. The line *ef* is pleasing, but when cast singly the mold must be jointly down as in *gh* by hand tooling and such partings are delicate and liable to leave irregular edges on the casting which will be ground off quite artlessly by the casting cleaner. If machine molded the metal pattern cost will be increased greatly by the necessity of mounting pattern parts accurately on both sides of the match plate and any slight shift in the mold when it is closed will result in offset castings.

Practical Considerations Are Best

Practical considerations are in best taste, particularly if ostensibly sound effects are liable to miscarry in process. Fig. 6 (Bottom) two patterns on a match plate, may look quite as well in place as the design at the top. It molds entirely in one-half of the flask, drag or cope as desired and if metal patterns are advisable they will locate entirely on one side of the match plate. No "shift" is possible and if intensive production is required this job, like all work with one plane side, may be cast in stacked checks, one above the other, the bottom of each mold serving as the top for the previous one. While opportunities to exercise judgment in these matters are daily before the designer he may fail occasionally to realize an advantage.

In heavy work, cored holes are advisable when they avoid a machine set up for an operation in which extreme accuracy is unimportant, as the foundation bolt holes in Fig. 1. They also are advisable when they tend to make cast sections more uniform and less liable to shrink cavities. Otherwise no burden should be put upon the foundry that may endanger the uniformly successful production of castings involving much labor or which may introduce the possibility of unexpected hand labor in assembly. Apparent savings in the machine shop by elimination of covers designed for core removal often result in no over-all gain due to the uncertainties and disorder of cleaning room operations as compared to the charted and timed machine tool operations which are so sure of uniform results.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Study the Home for New Markets

INDUSTRY'S new market lies in the modern home. With building activity falling behind normal requirements at the rate of 270,000 residences annually a tremendous potential outlet for millions of dollars worth of domestic machines and equipment is being created. It remains for American industry with its keen engineering brains, ability and foresight to meet the challenge and turn this source into a profitable consumer.

The steel industry already has made progress with its welded steel house covered with porcelain enamel shingles. Plans are under way in large cities for housing facilities on a large scale. To the designer all this means the development of fabricating machines in increased number and of modern type. His field, however, extends beyond that. With these modern homes must come more up-to-date household machinery. Equipment may be built into the walls as an integral part, on much the same plan as the built-in motor on a modern machine. The steel house lends itself more to this type of construction due to its increased strength and more substantial means of fastening.

Now is the time for the designer to show his ingenuity. Our modern mass production methods are capable of manufacturing economically; what we lack are more new ideas for products that will appeal to the public and which are within its reach.

Confining Power to Smaller Space

CONSERVATION of space should be one of the primary aims in design. When an important manufacturer in the automotive industry recently set out to build a motor bus with the greatest possible percentage of floor space available to passengers its engineers went to work on an engine of radical design. The result was a 12-cylinder horizontally opposed unit, Fig. 1, of such low overall height that it could be mounted below the floor.

The engine, transmission, clutch, etc. did not necessitate a kickup in the floor because of the study which had been given to installation requirements. A flywheel of small diameter is employed and the two carburetors are located under seats on opposite sides, with combustion air taken in through the sides of the body. Thus the layout of this power plant application gives unrestricted riding area for 44 seated passengers and 56 standees, a total of 100 passengers. The bus and engine were built by White Motor Co., Cleveland.

Crankcase of the engine is aluminum alloy with all main bearings secured by through bolts. Cylinder blocks are held to the crankcase by through bolts in addition to studs, but permit removal of cylinder blocks without disturbing main bearing adjustment. All main bearings are heavily ribbed, and all main oil delivery passages are drilled in the case. Special nickel chromium alloy cast iron was selected for the cylinders, with exhaust valve seats of the screwed-in type which already have made mileages in excess of 100,000 possible without re-

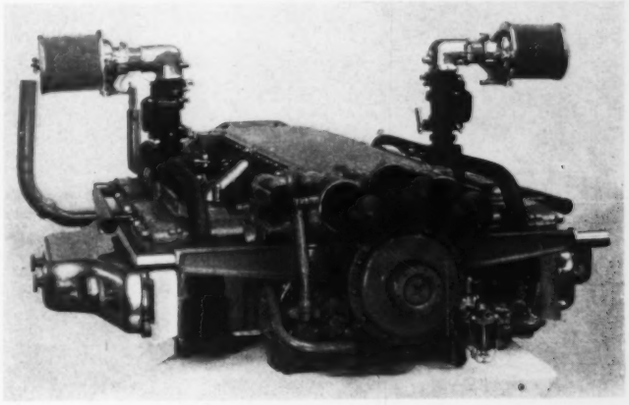


Fig. 1—Design of this engine with horizontal cylinders reduces overall height considerably. Horizontal type engines may be needed if rear-engined cars mature

grinding. Aluminum alloy is used also for the cylinder heads.

The pressure lubrication system is of the dry sump type so that cylinder lubrication is not affected by grades, and the oil sump which is built over the crankcase permits oil to leak from the sump through the oil pump to the crank-

case when the engine is standing long enough to get cold. The arrangement allows connecting rods to dip when the engine is first started, thus automatically giving excess lubrication to cylinders and pistons when starting cold. This desirable feature is important in prolonging the life of cylinder bores, pistons and rings, and at the same time minimizes crankcase dilution.

Propeller Design Balances Forces

PROBABLY no better stimulant for bringing out new ideas is to be found than designing a unit to meet requirements for which little precedent exists. That is what Gar Wood did when he developed MISS AMERICA X. One result was the use of a propeller, Fig. 2, embodying a new principle.

Fundamental differences between the blade of the new screw and that of the conventional type are in the working surface which has been re-aligned, and in the redistribution of weight. With this design, developed by Federal-Mogul Corp., Detroit, the bending strain resulting from centrifugal force actually is redirected in such a manner that its effect is in exactly the opposite direction to the thrust load.

The new principle lies wholly in the fact that the working surface of the blades is generated on something in the nature of a V-thread formation. Blade flexure always has been a problem in connection with high speed operation for although a blade may be able to withstand permanent distortion under its normal load there is tendency for it to flex in use within its elastic limits, particularly as it passes through the strut stream. This flexure causes momentary change of pitch which expresses itself in noticeable vibration. The new blade designed apparently resists this vibration to a far greater degree than the conventional type.

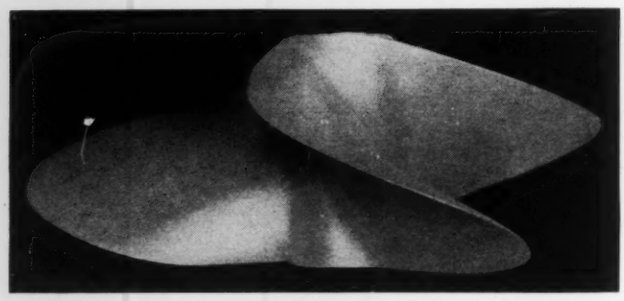


Fig. 2—Centrifugal force balances thrust load in the operation of a new type of speed boat propeller

Watch Electron Tube Progress!

COMPANION of the electric eye, the keen sense of sight of which has been the basis for hundreds of applications in design, electronic apparatus employing infra red rays promises to provide a sensitive means of feeling. When the Macneil thermo-electric sextant, employed to determine the position of the sun through thick clouds, was pointed out of the studio window during a recent demonstration, its sensitive thermocouple "felt" the heat from smokestacks six miles away.

Navigation, industrial applications, remote control and safety appliances all present striking opportunities for infra-red detection, *Electronics* says. Experiments now being conducted by Commander Macneil include the location of airplanes flying above the clouds at night by "feeling" the heat from their exhausts. An appreciation of the sensitivity incorporated in this instrument may be gained from the fact that it will detect the heat of a man's face at a mile's distance and that of a horse's at two miles.

In war a smokescreen no longer will be vital in protecting warships—their hot funnels betray them to the new device. Icebergs cease to be enemies of navigation, a recent demonstration disclosed. A cake of ice hidden behind a thick sheet of black rubber to simulate fog, with all lights in the studio turned out, was located instantly by the thermocouple which swung around the "horizon" and spotted the concealed "iceberg." With such progress in this development designers soon may have a medium of feeling as well as seeing by automatic means.

Sprayed Metal Offers Possibilities

SPRAYING of molten metal on surfaces of machine parts and equipment is being adopted by industry as an effective means of combating corrosion. The same process also is being employed to build up worn metal parts and may simulate the progress of welding. With a special spray gun any of the commercial metals obtainable in wire form may be applied in the molten condition and built up to any desired thickness.

In the operation of the gun the wire is fed over a flame which may be oxy-gas or oxyacetylene. The spray gun shown in Fig. 3 is employed in the process, owned by the Metallizing Co. of America, Los Angeles, and melts the wire by an oxyacetylene flame. Air pressure forces the molten spray out of the gun at a high velocity.

Mechanism of the gun may be divided into two essential parts, the wire feed mechanism and the gas head. A small 12-blade turbine in the rear part of the case is powered by air to drive the gears and a knurled feed roll which propels the wire through the gun. The top part of the case is hinged. A pressure plunger fitting over the idler shaft yoke is used to supply the necessary pressure to the yoke to engage the feed wire. Between the case and gas head body are the orifice plates for mixing and metering the gases. Smoothness of the coating is depend-

ent upon adjustment of the air cap that regulates the stream of air which completely surrounds the gas flame.

The bond between the two metals is made by force of impact on a thoroughly sand blasted surface, rather than by fusion of the two metals. A terrifice impact drives the atomized spray on to the metal on which it is applied. With a properly prepared base the coating becomes practically an integral part of the base material.

Conditions Must Be Studied

Designers specifying this process either as a protective coating or for building up parts need to watch that selection of the proper metals to be used, for any application embraces a thorough consideration of all the physical properties of a metal along with a study of the conditions under which it will be employed.

Sprayed metal is somewhat similar to cast iron and in many respects may be machined in the same manner, H. B. Rice, Metal Spray Co., Los Angeles, brought out in a discussion before the American Welding society. For example a sprayed bearing may easily be machined by taking fine cuts with a small round nose tool and finished with emery.

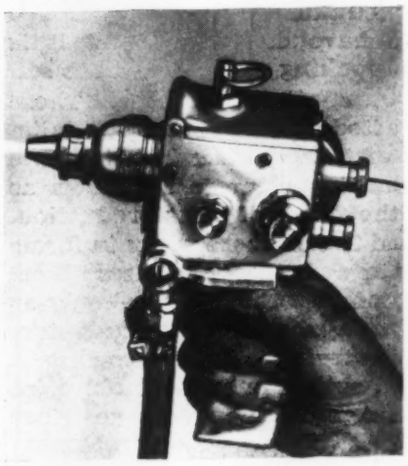


Fig. 3 — Typical metal spray gun employed in a relatively new process which is capable of providing a protective coating of one type of metal on a dissimilar material. Building up of machine parts is another field in which the process holds many possibilities

Press Embodies Multiple Rams

BECAUSE a unit is large it does not necessarily follow that the working parts are unrefined in development or construction. One example of exceptional design and workmanship is found in a recently developed steam platen press, Fig. 4, which has a maximum capacity of 20,000,000 pounds. Tested under working pressure, the greatest deflection anywhere in the platens did not exceed 0.004-inch.

Claimed to be the heaviest tonnage steam platen press ever built, engineers of the Lake Erie Engineering Corp., Buffalo, N. Y., designed the unit with twelve 18-inch rams. Steel construction is employed throughout with the exception of the semisteel rams. Columns are of special alloy steel showing an ultimate tensile strength of over 120,000 pounds.

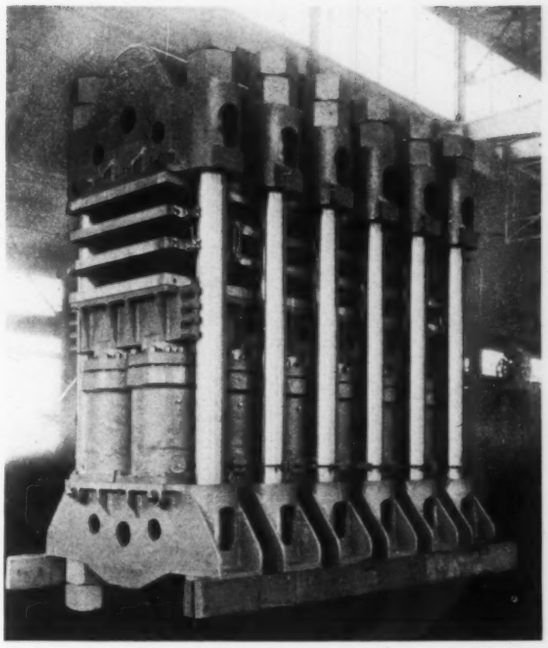


Fig. 4—Despite enormous capacity the platen deflection in this press does not exceed 0.004-inch

Centrifugal Force Augments Spring

CLUTCH practice is undergoing changes to keep up with modern trends. Recently it was announced by W. C. Lipe Inc., Syracuse, N. Y., that its engineering department has developed a new unit embodying unusual features. Twenty interlocked pressure levers are affected by centrifugal force to augment the clutch spring when the clutch is engaged and retard the action of the spring when disengaged. This is said to effect nonshock engagement and compensate automatically for loss of spring pressure resulting from wear on the facings.

Because the clutch spring has no direct contact with the pressure plate it is well insulated from the source of heat. Pressure from the spring is multiplied through the levers acting on the pressure plate and since these levers form a discordial plate the pressure is applied evenly; thus no deformation of the pressure plate occurs through lever action.

APPLICATION of the reversed refrigerating cycle as a heat pump (M. D. April, page 26) to heat the Southern California Edison building has been watched intensely by engineers. Now comes a statement from H. L. Doolittle, chief designing engineer of the company, to the effect that the installation was practical and economical last winter.

IT is not enough today to have a machine that is mechanically perfect. Appearance is exerting an increasing influence on final selection by the purchaser. Mr. Teague, who points out how this factor may be included in design, is consultant for Eastman Kodak Co., Thomas A. Edison Inc., Taylor Instrument Cos., Marmon Motor Car Co., and other industrial organizations.

Supplementing Mechanical Efficiency with

By Walter Dorwin Teague

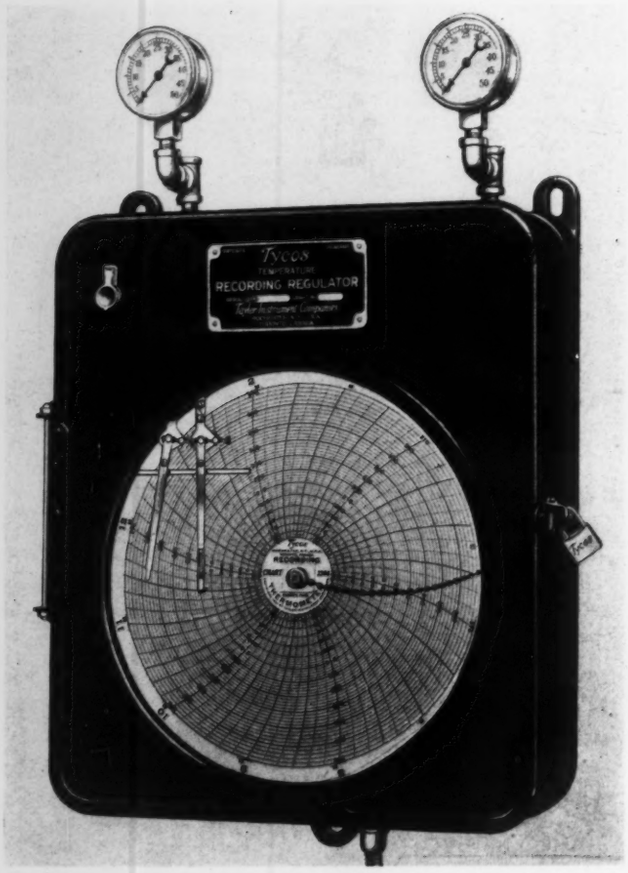


Fig. 1—Even purely utilitarian instruments offer many possibilities to the industrial designer for developing improved appearance without loss of efficiency

THE artist is a factor in industry today, but not through any initiative of his own; he has been dragged there by practical-minded business men who have discovered that it is easier to sell a good-looking machine than to sell the same thing in an unattractive guise. These executives have drafted the artist as a specialist in the appearance of things, and given him the job of injecting what has come to be known as "eye appeal" into the fruits of mass production. The artist is expected to cast these wares in forms which will stimulate a desire to possess them.

The artist—he prefers to be known simply as a designer—is thus a newcomer in industry, but the instinct he is serving is by no means new. It is, in fact, as old as human manufacture, as strong in the Stone Age or among savage tribes as it is today on Park avenue. Fine workmanship and good looks always have been inseparable. Appearance always has been an index of quality. The novelty in our present situation is our very recent discovery that this instinct cannot be neglected in the Machine Age any more than in the older periods of handicraft.

There is, of course, another new condition inherent in machine production. The technologies of today are enormously complicated, and no artist is competent to plan the technical side of modern production. On the other hand, I doubt if many engineers have the equipment which an experienced industrial designer can bring to the problem of external appearance—his trained sense of design, his knowledge of style trends, his invention rendered more fertile by practice in many diverse industries. It follows, then, that the two must work together. They must travel in double harness and each pull his share of the load if our machines are to be as good looking and as satisfying as they are efficient.

Also, if the results are to be really satisfactory, these two must work together from the very

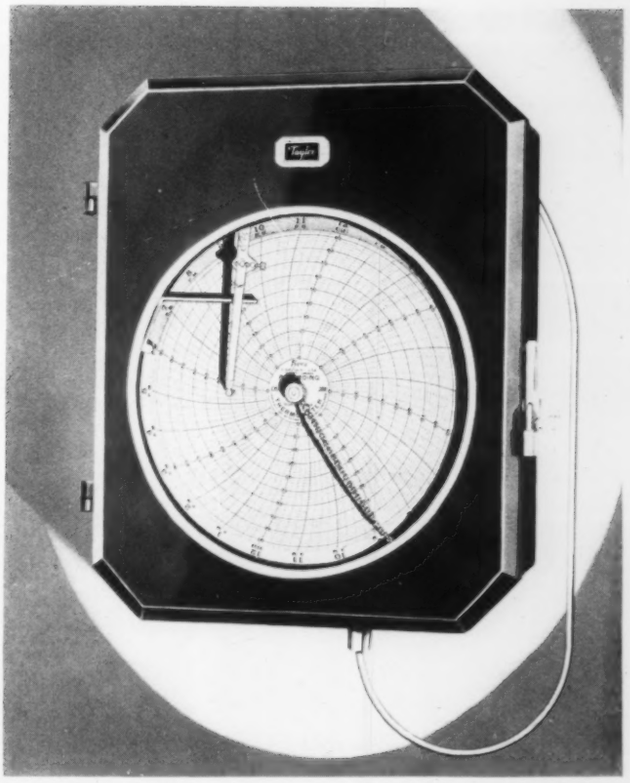


Fig. 3—Improved lines reveal quality and indicate attention to all details. This is a redesign of Fig. 1 as made by the author

Good Appearance

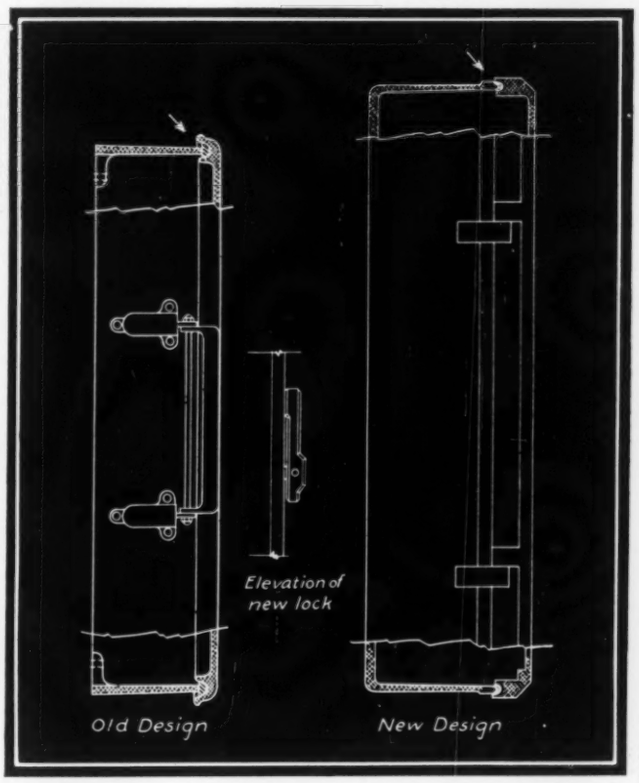


Fig. 2—New design brings the lid into closer relationship with the case and gives an appearance of better fit

inception of a product. Whatever you want to call this quality we are asked to get into our work—good looks, style, eye appeal, beauty—it is not something you can smear over a finished product like a coat of paint. It must be built in from the start. It is just as fundamental as good looks in a woman; she may be able to do a lot with rouge and lipstick but she never will be a real beauty unless her features are rightly proportioned, her bones and muscles sound, and her complexion and color good.

In the same way good looks in a manufactured article must be the result of sound construction clearly revealed; well organized relationships between elements so that a unified whole results rather than an assembly of unrelated parts; fine lines, fine proportions, fine surfaces; above all, that look of skilled workmanship and high efficiency which in a machine corresponds to the look of health and vigor in an athlete.

Practically everyone responds immediately to these attributes. Look at the dazzled crowds which gather around those beautiful stripped chassis and motors exhibited at the automobile shows, or observe the awe with which people crane their necks at the AKRON sailing overhead. This kind of response has nothing consciously to do with art, but it is to my mind a far more important evidence of artistic appreciation than the frequenting of picture galleries or grand opera. And it has a direct influence on the sales of merchandise.

It is the industrial designer's business to satisfy this love of finely-made, well-organized, beautifully-functioning products. This kind of work cannot be done in his studio or at his drawing board. It must be accomplished in the factory and in an engineering department, and it must be done in close co-operation with the men responsible for the design and production of the mechanism. An industrial designer passes from one problem to another, for he may work alternately on kitchen ranges, gas furnaces, cameras, washing machines, clocks, automobiles, glass-

ware, lamps, radios, or purely industrial machines. The principles of design are always the same, no matter where they are applied, and the designer specializes only in design from the

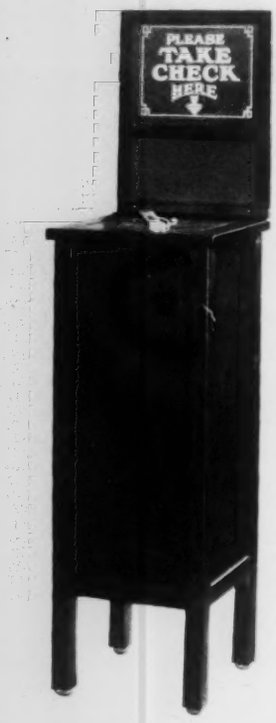


Fig. 4—Original cafeteria check register, although efficient, does not symbolize quality

organization and final appearance standpoint. On the technical side and the special requirements of a given problem he must, and does, rely entirely on the engineer in charge.

Perhaps it will be easier to explain what a design consultant does and how he works if we discuss specific problems, setting forth just how they were solved. Let us take, for instance, a case for recording temperature and pressure regulators manufactured by the Taylor Instrument Companies. This case as it formerly appeared and as it was redesigned is shown in Figs. 1 and 3. Here is a purely utilitarian instrument installed in power plants, engine rooms, dairies, etc. Perfect accuracy and dependability are, of course, its first requirements, but the manufacturers felt, and proved, that fine appearance in this type of instrument has a definite appeal to the engineers and executives responsible for its selection. They wanted the quality of the instrument to be revealed or symbolized in the design of its case. There was no question of "prettyfying" or decorating; it was plurely a question of *organizing* the lines, the surfaces and the necessary mechanical details into an impressive and satisfactory whole.

The case proper is in two parts, a box to contain the mechanism and a lid to close it. This mechanism must be easily accessible for setting and for the changing of charts, but it also must be locked against any tampering, and it is important that it be watertight. The two parts of the new case are die cast, and with the present advancement of the die casting art it is no longer necessary or desirable to break up the surface with beading or graining to conceal defects in the casting. Hence it was decided to make the castings perfectly smooth and to finish them with a rubbed black or white lacquer. Instead of rounding all angles with a large radius, the shape was reduced to a crisp and clean-cut arrangement of bevels. New and much simpler hinges were designed, together with a neater and more compact latch and lock. A narrow, chrome plated bezel was placed around the dial opening to relieve the severity of the black case. The large panel of lettering on the front of the case was removed to the interior and replaced by a small enameled name plate in silver with a touch of vermillion, adding a pleasant note of color. In all these details the main motive of octagonal forms and clean-cut bevels was carried out.

One of the principal problems in this product was its sealing against moisture. This is accomplished by inserting a band of sponge rubber

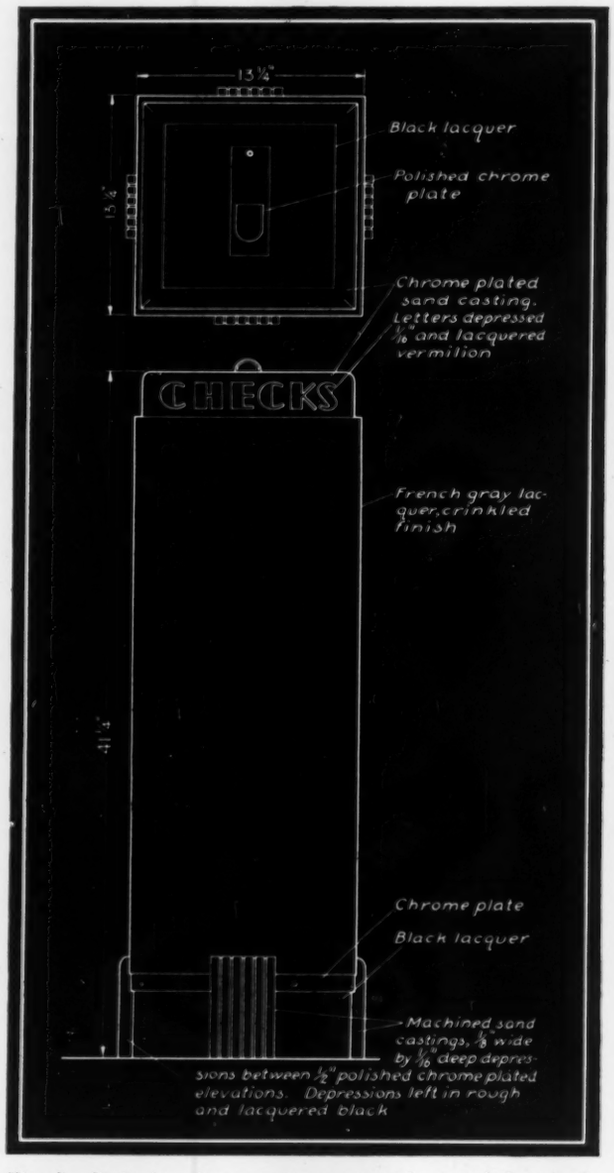

13¾"
Black lacquer
Polished chrome plate
13¾"
Chrome plated sand casting. Letters depressed 1/16" and lacquered vermilion
CHECKS
French gray lacquer, crinkled finish
41¼"
Chrome plate
Black lacquer
Machined sand castings, ⅛ wide by 1/16" deep depressions between ½" polished chrome plated elevations. Depressions left in rough and lacquered black

Fig. 5—Redesign for appearance can be carried out effectively without introducing complicated construction

in a groove cast in the lid, this sponge rubber being compressed over a flange on the box. In the old case the closure was so handled that the lid was much larger than the box and bore little relation to it. In the new case the overhang of the lid was reduced considerably and the box stepped-up to meet it. This slight ledge on the box near the lid has a practical value in deflecting water from the aperture.

Whether the new case is more "beautiful" than the old is a matter of no importance. The point is that the new case is organized much better. It has a look of fine workmanship, of high efficiency, of having been carefully thought out in every particular. The prospective buyer can see at a glance that the making of this instrument was so important to its manufacturer that he was willing to give careful consideration to every detail. It inspires confidence and respect, and the reception accorded it by its buying public proves that the effort was worthwhile.

Appearance May Retard Sales

Quite a different problem was afforded by the check register designed for the General Register Corp. This machine is used in cafeterias for the dispensing of checks. The customer withdraws a check or ticket from an aperture at the top and a bell is rung inside to attract the attention of the cashier. The old design, Fig. 4, had been in use for a number of years, and owners of smart and carefully furnished cafeterias had begun to manifest a reluctance to install this machine among their more up-to-date equipment.

On investigating the old housing it was found that some expensive processes were employed in its construction. In the first place, it was built of steel to imitate wood—a fundamentally false proceeding. To simulate wood construction it was assembled with projecting posts at the corners. These posts in the case proper were hollow angles to which sheet metal plates were spot welded. Below the case the angles were turned in and welded to form square legs. This was expensive as well as unsatisfactory because the welding of the corner strips for only part of their length set up a strain which caused them to "toe in" at the bottom, making it practically impossible to keep the legs truly straight.

As a climax the whole case was finished to imitate mahogany, and this type of finish costs much more than an ordinary lacquer such as is appropriate on metal surfaces. The admonition "Please Take Check Here" was lettered on a steel placard supported by two steel uprights at the back of the case.

In redesigning, we could not be satisfied with quite such classic severity as in the recording regulator case. The check register was to be seen and used by the general public and should

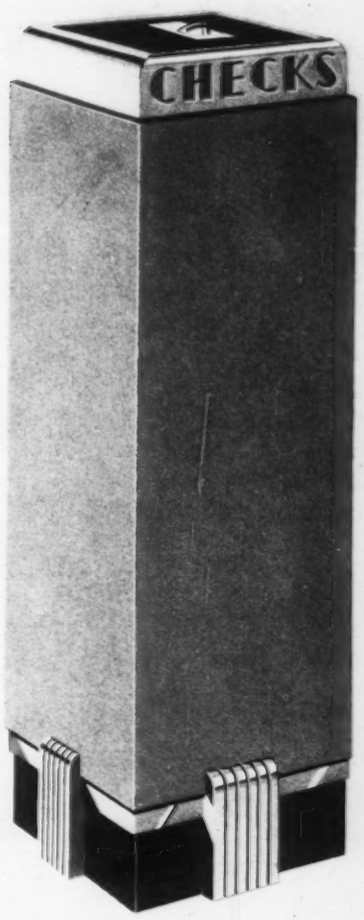


Fig. 6—Production advantages as well as improved impression are gained by restyling

be a decorative feature in any interior in which it was installed. This effect, however, was not to be obtained by elaborating it but, again, simply by *organizing* it into a well proportioned and attractive simplicity.

If a rectangular upright case is wanted, the obvious and easiest way to construct it is by forming a single sheet of steel into the shape required, Fig. 6. This was the first element in the design. For practical reasons it was not desirable to continue this case to the floor; some protection was needed at the bottom against the toes of customers and the mops and washing solutions of charwomen. Therefore inside the sheet metal case at the bottom was nested a band of chrome one inch wide, and inside this again a band of acid resisting black japanned metal four inches wide. To provide a more stable base and at the same time supply a decorative high-light, four cast and chrome plated supports were added in the middle of the sides. The housing was completed at the top with a chrome plated casting three inches high rounded with a curve similar to that on the bottom braces. This casting holds a black lacquered plate from

(*Concluded on Page* 68)

Stress Problems Are Discussed

INCREASED importance of more exact analytical determination of the stress in materials as affected by fatigue and creep, and the place of the engineer in activities leading toward the restoration of economic stability were topics given unusual prominence in the technical sessions of the American Society of Mechanical Engineers' annual meeting held recently at New York. Several speakers emphasized the point that considerably more research is needed in the determination of creep and fatigue stresses, and also that the importance of these two factors legislates against neglecting them when designing certain types of machines.

"Whenever machine parts are considered, the importance of localized failure, leading to a spreading crack under loads repeated hundreds of thousands of times, becomes vitally important, and the limitations of the mathematical theory, as applied to actual metals, becomes apparent," according to H. F. Moore. He continues, "For example, the mathematical theory of elasticity indicates that the localized stress at a notch, a screw thread, or a small hole depends not at all on the material, but only on the shape of the piece. Actually metals differ widely in the ratio between the load which, if often repeated, causes failure in a piece containing a notch or screw thread, and the load which will cause failure in a similar piece of the same metal in which the notch has been smoothed out or the screw thread turned out."

Need Additional Creep Data

Considering applications of creep tests, Gleason H. MacCullough, stated "In the general case of design, the most frequent problem facing engineers is that of designing a part for operation at a particular temperature of a material for which experience exists at lower temperatures. If the material is unaltered, it is usual to base design upon existing practice by reducing the ratio suggested by creep tests at the two temperatures."

N. N. Davidenkoff pointed out that "The yield point and tensile strength of a material under impact are always higher than those at low-speed tests, the yield point rising more rapidly than the strength. Working conditions of a material under impact are less favorable than those under static action of a force. As far as these two circumstances compensate each other, it is recommended that in calculations for impact the same allowable working stresses be used as for static conditions, employing the data obtained in static tests. (Neglecting, however, consideration of the reliability of the calculations.) The impact test for notched specimens can be used only as a check test, approving the use of a material or rejecting it; in determining the allowable stresses to employ, however, the results of such tests are of no value."

Machining Rate Higher

Discussions of materials did not concern themselves solely with stress distribution however. Enrique Touceda developed the point that "Malleable iron can be machined at a higher rate of speed for equal cuts than any other ferrous product of similar mechanical properties. That the castings are both fine grained and free from internal stress results from no effort on the part of the manufacturer to bring about such a fortunate condition, but is an accompaniment of the character of heat treatment that the hard iron castings must undergo in order that they can be converted successfully into the finished product. If the castings have to be welded, or if in service they are subjected to severe wear, they are being put to a use for which malleable castings are ill fitted."

Determination of product characteristics from the consumer's viewpoint was presented as one of the major management essentials for recovery by Carle M. Bigelow. This speaker emphasized the engineer's place in the recovery program and stated that the minimum volume that can be absorbed by economic distribution efforts should be determined and the manufacturer should organize to produce this volume.

A paper dealing with the determination of the number of active coils in helical springs by R. F. Vogt is abstracted in an article on page 37 of this issue of MACHINE DESIGN.

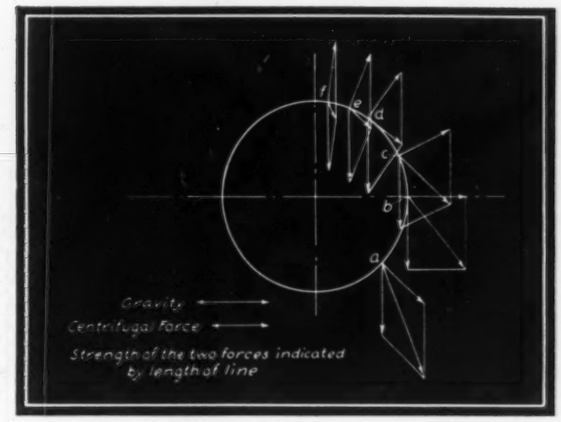


Fig. 1—Oil on the periphery of revolving wheel is subject to gravity and centrifugal force

By W. H. Himes

Splash Lubrication Fails at Subcritical Speed

CONSTRUCTION of enclosed gearing reasonably might seem to be an established art. Engineers who incorporate gears in design of their machines however, if not fully conversant with gearing problems, too frequently create mechanisms which for no apparent reason fail to function. There seems to be a widespread conviction, even among designers familiar with gearing, that almost any combinaton of wearing surfaces may be enclosed in a splash lubricated case with assurance that oil will find its way to all the surfaces that need it. Quite often this optimism is justified by results, but occasionally difficulty is encountered with resultant undue wear or complete failure in operation. In such cases the laws of nature have been violated. It is the object of this article to discuss some of these laws and their application.

First, a word about one of the errors of operating splash lubricated units, which still is too frequent—namely excess oiling. In spite of instruction tags and other educational measures taken by manufacturers, the impression is too prevalent among the rank and file of machinery users that an excessively high oil level can do no harm, and may be even an improvement. To what height should the oil stand in a splash lubricated case? The ideal height to provide for in the design of the enclosure is such that the gear that does the splashing should skim the surface sufficiently to secure efficient distribution, and no more. Any excess over this requirement will cause loss of power and excess heating due to the churning of the oil. It is not at all beyond the bounds of possibility to overheat in this way so much as to damage the bearings and other parts.

It is well to bear in mind in this connection that the temperature limit at which ball and roller bearings become susceptible to permanent injury is about 350 degrees Fahr. Several manufacturers give assurance that their bearings will operate continually at this temperature without damage. The results of the tests from which these data were obtainod do not indicate that exceeding this temperature will cause im-

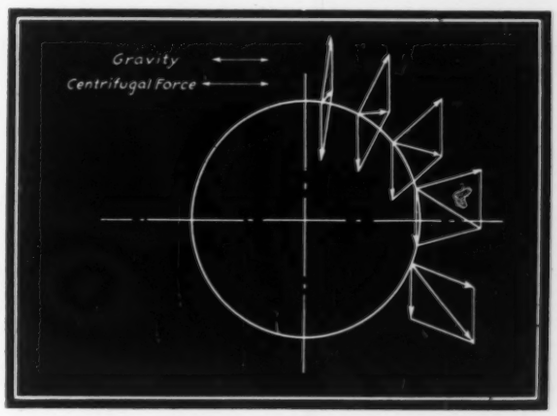


Fig. 2—When centrifugal force equals or exceeds gravity the vectors point away from the periphery

mediate failure, but rather that there is a perceptible softening of the steel beginning around that temperature. The exact degree at which such effect occurs depends, of course, upon the composition of the steel. In some cases bearings under certain load conditions would operate successfully even at 400 degrees Fahr. These excess temperatures would amount to "drawing" treatments of the steel and would result in no damage unless carried so far as to reduce the elastic limit to the region of the working stress.

How slowly can a gear run, and still splash effectively for lubricating? This is a question

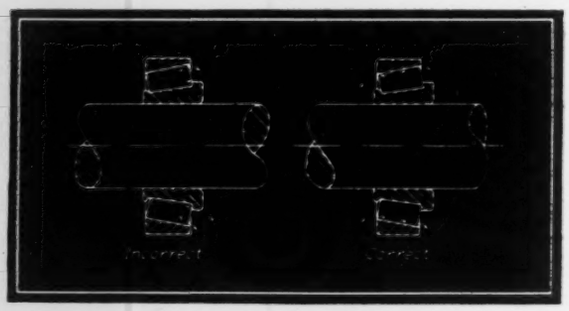


Fig. 3—Oil should be introduced at smaller end of roller bearings, as indicated by arrows

which the designer must face. A simple formula may be deduced for determining the critical speed where splashing ceases, in any given instance. It is evident that the oil on the periphery of a rotating wheel is subject to two forces —gravity and centrifugal force. In Fig. 1 gravity is assumed to be slightly stronger than centrifugal force. The effect of these two forces has been worked out at various points on the periphery by drawing the force parallelogram and finding the magnitude and direction of the resultant force. Thus at stations *a*, *b* and *c* the combined action of these forces is to overcome the adhesion of the oil to the gear and to pull it off.

The reader should note carefully that these vectors in no wise indicate the actual motion of the particles of oil after leaving the wheel, but a resultant force tending to separate it from the wheel. Once the drop is released it must start its trajectory in a direction tangential to the periphery at the point of separation. Obviously, the direction in which the drop flies depends upon the direction of rotation, whereas the vectors shown in Fig. 1 are unaffected by the direction of rotation.

At station *d* the vector is tangent and no result could be expected other than to cause flow along the periphery. At stations *e* and *f* the vector points inward, tending to draw the oil toward the interior of the wheel. Evidently then, no splashing effect can be expected from station *d* on up to the top of the wheel. The tendency begins at too low a point to guarantee successful lubrication. To insure satisfactory results the speed should be great enough to throw off oil, even at the topmost point. Viscosity enters into the problem to some extent, but apparently only to the point of varying the amount of oil thrown off, rather than affecting the critical speed. To attain the desired end the speed must be such that centrifugal force equals or exceeds gravity. Then the various resultant vectors will point away from the periphery of the gear, as shown in Fig. 2.

To this end let us consider the equation for centrifugal force in the popular form in which designers apply it.

$$F = .000341\, W\, R\, N^2 \qquad (1)$$

where F = centrifugal force, W = weight of object, R = radius of wheel and N = revolutions per minute.

Now as centrifugal force is to equal the weight, or the effect of gravity, for the critical condition, make $F = W$ in the equation, whereupon they cancel and disappear. The equation then becomes,

$$1 = .000341\, R\, N^2$$

or

$$N^2 = \frac{2935}{R} \qquad (2)$$

As either of the two terms N or R may be variable, we can solve for one with the other fixed.

Consider a case where a given unit has a splash wheel 1½ feet in diameter, and it is desired to know how slowly it may be run with

(*Concluded on Page* 53)

Fig. 4—Totally enclosed mechanism lubricated by splash method (covers removed). Oil flinger is driven by roller chain

Unitization—Logical Sequence to Interchangeability of Parts

By Arthur H. Adams

ALL matured complicated mechanisms tend to divide into units. Such units, however, rarely can be interchanged without adjustment, i.e., they are not strictly *interchangeable.*

Some interchangeability of parts long preceded strict limit gaging and true interchangeability in manufacturing practice, but real gains in interchangeability were not made until it became a procedure of design to set such limits and gaging standards on *all* parts as would produce a properly operative machine without selection or fitting in assembly.

Unitization is the extension of the 100 per cent interchangeability idea to functioning units, and means so designing any mechanism that it breaks into self-contained units, adjusted to *operating* as well as dimensional limits, such that a complete operative mechanism may be assembled of such units without selection or adjustment.

Assembly Savings Afforded

This principle makes great demands on the designer, but it leads to assembly savings comparable to those due to interchangeable parts. It frequently permits larger parts tolerances. It leads to surprising savings in stockkeeping. Repair work comes naturally into the factory because repair on unitized mechanisms consists of replacing units not parts, usually by the user. Investment in old product, now weighing on manufacturers, is lightened because the stockroom, the dealer, the user do not care how much or often your units *A, D* and *Q* are redesigned *internally.* Your model *T* may run on for years, and yet be ever new and up to date. Any desirable change can be made at any time, limited only by factory stock of parts for the unit affected, provided that 100 per cent interchangeability with old units is kept.

Before considering broadly modes of attack on the problems of unitization, there is a certain convenient terminology that conveys something of the technique. Most units have operating or force-transmitting relationships to others (frame units being sometimes an exception). These operating relationships being in the last analysis relations between positions of surfaces, one convenient distinction is between the two kinds of surfaces that must be controlled. One kind, the mounting, registering or stopping surfaces, determines the relative positions of co-operating unit frames. These surfaces may be called "mating" surfaces. One speaks of the "mating surfaces of unit *A* vs. unit *B.*" These may be mere machined surfaces on the frame of unit *A,* or a set of three bosses or adjustable stops, etc. Unit *A's* mating surfaces vs *B* necessarily will make contact on the mating surfaces of *B* vs *A.* In other words, *A* and *B* have "mutual" mating surfaces.

It does not follow that there are mutual mating surfaces between every pair of co-operating units. Units *C* and *D* may be held in mutual relationship by the relation of each to unit *E.* In that case *C* and *D* both have mating surfaces vs *E;* and *E* mating surfaces vs both C and D. The more particular the operative relation be-

UNITIZATION will be one of the watchwords of the future! The possibility of bringing out special models of machines or lines of new models without obsoleting previous designs is an ideal, yet it can be attained by combining interchangeable unitized mechanisms. Mr. Adams is consulting engineer, New York, member American Society of Mechanical Engineers, Fellow Royal Society of Arts, and Fellow American Association for Advancement of Science.

tween *A* and *B* the more reason for providing *A* and *B* with direct mutual mating surfaces.

Surfaces of a second kind, usually on moving parts, and ones by which motion is transmitted from one unit to another, are called "working" surfaces.

Surfaces Must Have Right Relation

One of the most basic items of the technique of unitization is that, in any two co-operating units *A* and *B*, *A's working* surfaces vs *B* always must be related to *A's mating* surfaces vs *B* (or, if the mating is indirect, to those mating surfaces of *A* that determine *A's* positional relation to *B*), and *B's working* surfaces vs *A* must be related to *B's mating* surfaces vs *A* by such dimensions and tolerances that a proper operating relation invariably results between *A's* and *B's* co-operating *working* surfaces regardless of interior changes in the unit. Moreover this relationship must be controlled in all vital positions, i.e. in all vital phases of an operating cycle.

In other words the relation, and the gaging of the relation, of a working surface of *A* to a co-operating one of *B* is broken up into two parts:

(a). the relation (in *A* alone) of this working surface of *A* to *A's* mating surfaces vs *B*.

(b). the relation (in *B* alone) of the right working surface of *B* to *B's* mating surfaces vs *A*

Let us fix these thoughts by a schematic example. In Fig. 1, assume that unit *A* contains a set of cams and cam followers the duty of which is to protrude and withdraw a group of rods *l* when any of the desired buttons 1, 2, 3, 4, 5 are depressed. Unit *C* is a one-revolution clutch transmitting to shaft *n* just one revolution each time start rod *m* of unit *A* is protruded (by the depression of a button) to press trip rod *t* of unit *C*. Push rods *l* operate tape punches *p* and thereby punch a five unit code of holes in a heavy paper tape fed through unit *B*. This tape may be for operating a giant electric typewriter. It will be understood that this is all a purely fictitious mechanism.

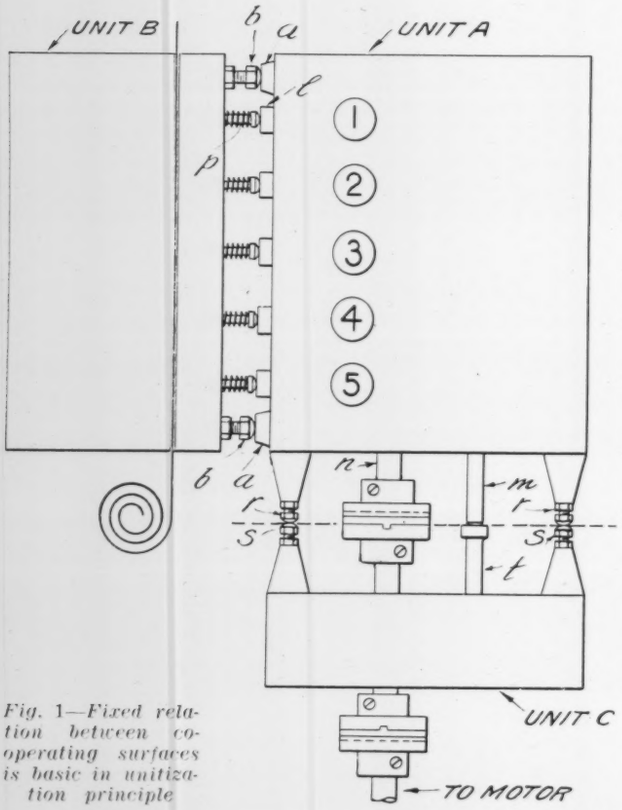


Fig. 1—Fixed relation between co-operating surfaces is basic in unitization principle

THE subject of unitization is so new and presents so many interesting problems, differing vastly in detail from one machine to another, that only outlines of the most broadly applicable principles can be given. In spite of general hints as to mental approaches, there is no substitute for ingenuity. Unitization may be a fertile and powerful method of original design as well as a principle of economical manufacture, and the results will be simpler and better mechanical movements.

Push rods *l* are shown retracted and in this position must permit punches *p* to withdraw completely into the stripper (see Fig. 2) and thus release the tape. They should not withdraw deeper than necessary, say 0.020-inch under flush, lest time be lost. The extended position of push rods *l* must force punches *p* inward far enough to enter the dies and perforate the tape but, to save wear, not a great deal farther. Let us say between 0.010 and 0.030-inch entrance.

In the detail view of the punch and die Fig. 2, these limits are shown, and the allowable stroke of the punch is indicated with its extended or operated position measured from the die surface, dimension *X*, and with its nonoperated position measured from the stripper surface, dimension *Z*. From these and the details is calculated dimension *Y*. These two operated and nonoperated position dimensions, *X* and *Y*, show severe requirements on the operated and nonoperated positions of push rods *l* in relation to the die face when the possible parts variations in unit *A* are also considered, and if the result were to be attained solely by close parts tolerances as in a nonunitized design.

It will be noted in the following how these conditions are eased materially by unitization. This simple example, primarily intended to illustrate the partition of working tolerances be-

tween two mating units, also serves to show the relaxation of parts tolerances that unitization often permits.

Stop screws *b*, Fig. 1, i.e. *B's* mating surfaces vs *A*, are adjusted to the gages shown: *GA*1, *GA*2, *GA*3 *and GA*4, Fig. 3.

There is high probability that among the five punches of one particular unit both extremes of length, 1.010 and 1.000 inch, will not exist. If this is true the tolerance of 0.012-inch between *GA*1 and *GA*2 is widened practically thereby. *GA*3 and *GA*4 are really checks on *GA*2 and *GA*1 respectively and on the 0.040-inch minimum 0.045-inch maximum paper clearance dimension. They might be omitted readily if this dimension and the punch length dimension are reliable. Clearly it normally will not be difficult to adjust unit *B* to these gages.

In unit *A* the stop bosses *a* might be adjustable stops like *b* but the conditions here favor a type of multiple surface alignment by machining

A DELICATE and intricate machine, manufactured in a number of models, was the subject of a complex 100 *per cent redesign directed by the author. The redesign was quite successful, realizing the advantages pointed out in the accompanying article, while a considerable part of the original tools were used. This intricate mechanism was operated and then disassembled in five minutes by use of a screwdriver to a couple of dozen simple units. Without adjustment and with only the screwdriver, it was reassembled in five minutes and again operated.*

that often is most convenient and economical in obtaining one of the working-surface-to-mating-surface relations. Assume that in unit *A*, with push rods *l* on the cam lows, i.e. fully retracted, the tops of push rods *l* and of bosses *a* are aligned as by a light grinding or milling cut. In some units the working surfaces might be machined stopping from the mating surfaces, or vice versa. In the case of unit *A* as shown, a good alignment of bosses *a* and push rods *l* is the only adjustment needed whatever the method used. This one adjustment eliminates all parts variations in *A*, i.e. it permits the tolerance to be very wide. It also is assumed that the *stroke* of push rods *l* in unit *A* can be held to minimum 0.067-inch, maximum 0.070-inch, to satisfy the punch-die and punch-stripper requirements.

The foregoing operative relation between units *A* and *B*, illustrating some of the primary ideas of unitization, is one of the simplest pos-

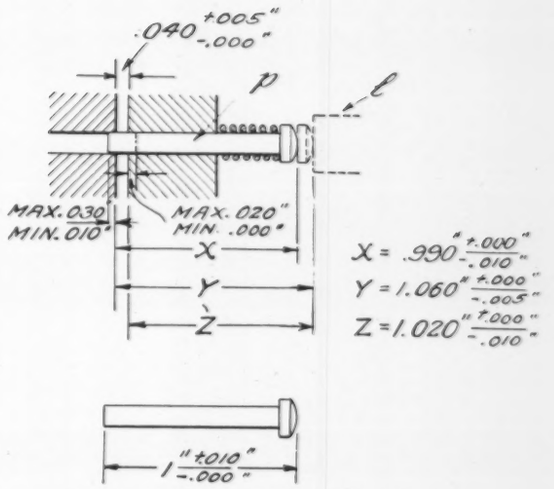


Fig. 2—Detail of working parts in stripper

sible. It involves only thrust and only two positions of the cycle at which relations need to be checked. The mutual mating surfaces of *A* and *B*, therefore, are required to have accurate position only along one axis. Torsions, up, side or down pressures, pulls, wedging, interference, and many other actions may exist in the operative relations between units. More complicated mating surface requirements may result. It often is necessary to position two units quite accurately relative to each other along two and sometimes three axes. The basic principle of holding to suitable limits, wholly *within* each unit, the relation of the working to the mating surfaces at various points of the cycle remains the same however complex that relation.

Two Working Relations Present

Fig. 1 illustrates other points. Thus unit *A* is shown with two different working relations to unit *C*, a rotary and a simple thrust relation. To set these relations satisfactorily one might adjust mating points *r* of unit *A* to align with the tip of start rod *m*. The coupling half on shaft *n* could also be set, for example, so that the face of the middle coupling member would align with points *r* as indicated by the dotted line. Then in unit *C* the mating points *s* would be aligned accurately to the end of trip rod *t*, and the other coupling half also aligned with them.

In many cases pressures, accelerations, frictions, inertias and other quantities may be involved, as well as positions and strokes, in the break up between units of functional or operative relations. For example, in unit *B* it might be necessary to consider the acceleration that the springs give to the punches *p* in order to be assured that the latter will follow back the push rods *l* without clatter. This simply means the springs must not be too weak. So far as unitization has been applied none of these quantities

has proved any more of a problem than in a nonunitized design.

The unitizing designer is forced, however, to analyze all mechanical actions rather more thoroughly than usual, especially as regards allowable tolerances of variation in stroke or timing. He usually will find that this close analysis shows the way to better operating margins, to much less exacting limits on parts, and to a set of operating tests (by units) individually and

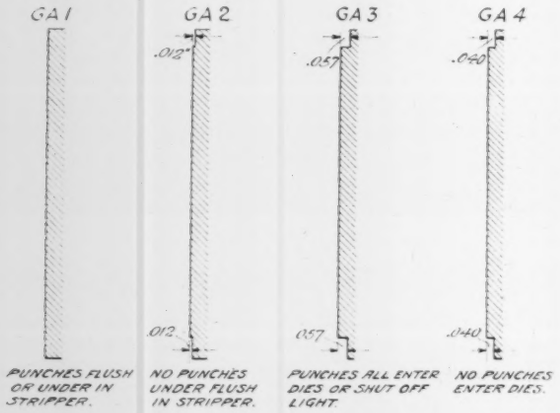


Fig. 3—Functional gages are used to control proper relation between parts

totally far simpler than the tests needed in the assembled mechanism to assure equally safe margins. Perhaps every designer of complex mechanisms has had the experience of discovering by peculiar sporadic failures how close to the margin of operativeness certain elements of a machine may be without the fact being detected by ordinary operating tests. The tests by units preclude any such concealed narrow margins.

The designer starting to unitize a machine as a rule will see his mechanism unconsciously in a few large natural units. After clearly visualizing these in their best relationship to each other, and perhaps refining this vision by making some schematic "unitized" drawings of each showing only general outlines, mating and working surfaces, the next step is to study one of these large units—say that one having the most contacts with the remainder of the machine (many and various working surfaces)—to see how best it may be unitized further. A fertile hint is to consider the mere causal relation between working surfaces. Consciously avoiding for the moment the vizualization of internal mechanism, consider which working surfaces of the big unit have something *done to them* and which ones, as a result, *do something*. The closeness or looseness of functional relation between the various "cause" surfaces and "effect" surfaces thus may be made more vivid, and some logical subdivision may emerge. The whole process is a functional rather than a physical analysis of mechanism. The object is the logical subdivision of mechanism by the work done.

Many simple units, easily assembled, adjusted and gaged functionally, rather than fewer more complex units, are best. Let more complex units, if possible, be assembled of simpler ones.

It will be obvious that gage design of a new order is required; functional or operative gages; accurate simulacra of units *B* and *C* to be used to test unit *A*. The best prototypes are to be found in the electrical industry where the most complicated mechanisms of the world—our power and communications systems—are the final physical product. Here a sort of unitization has been adopted unconsciously for sometime, and intricate operative gaging and testing methods for all kinds equipment, even whole circuits, have been developed. Pieces of electrical apparatus, though their mutual coaction is electrical rather than mechanical, may be regarded as interchangeable units of complex and complete operating mechanisms.

Functional Gaging Is a New Thought

The functional gaging of mechanically coacting units, with tolerances applied to *moving* surfaces and to mechanical forces and inertias is practically a new thought. A technique for limit gaging mechanical operation, a technique that barely has been foreshadowed, is required for unitizing. There is infinite room for creative work. In many cases it is enough to gage certain positions of moving surfaces, within predetermined tolerances as in the example in the foregoing, sometimes at several phases of the mechanical cycle. Inertias and forces, once an operative design is made, rarely are involved in the functional gaging simply because they are reasonably constant in a given design. Friction adjustments are exceptions but they rarely create more difficult problems in unitized than in ordinary designs.

The most basic way to consider one of these gages for a unit is that it must represent an idealized mating unit, able to register from the mating surfaces of the unit and to coact with the working surfaces of the same to indicate whether their movements and positions are between desired limits at all necessary phases of the cycle.

To executives and designers now considering redesigns or new designs of complicated nature this new thought is recommended for earnest consideration. The constant need of improvement and the high cost of tooling for cheap production are in perpetual conflict in the live designer's mind. Setting aside direct savings, a well unitized mechanism can be redesigned, cheapened and improved for years, unit by unit.

Fig. 1—Convertibility of the unit from a shovel (upper left) to a dragline is a feature of design

Control of Motion Solved in Power Shovel

By J. D. Rauch

MODERN power shovels incorporate numerous moving parts which must be designed to carry out a variety of manually controlled functions without loss of time or energy. Moreover, the space in which the mechanism is confined is limited and therefore compactness becomes a major feature in the design. Inasmuch as four or five complete operating cycles often are performed per minute, each function must respond instantly to the operator's touch on the control levers. The shovel also should be so designed as to be convertible easily and quickly into other forms such as a dragline, clamshell, crane backdigger or pile driver.

Typical of a unit in which these details have been embodied is the new heavy duty power shovel, Fig. 2, built by Ohio Power Shovel Co., division of Lima Locomotive Works Inc., Lima,

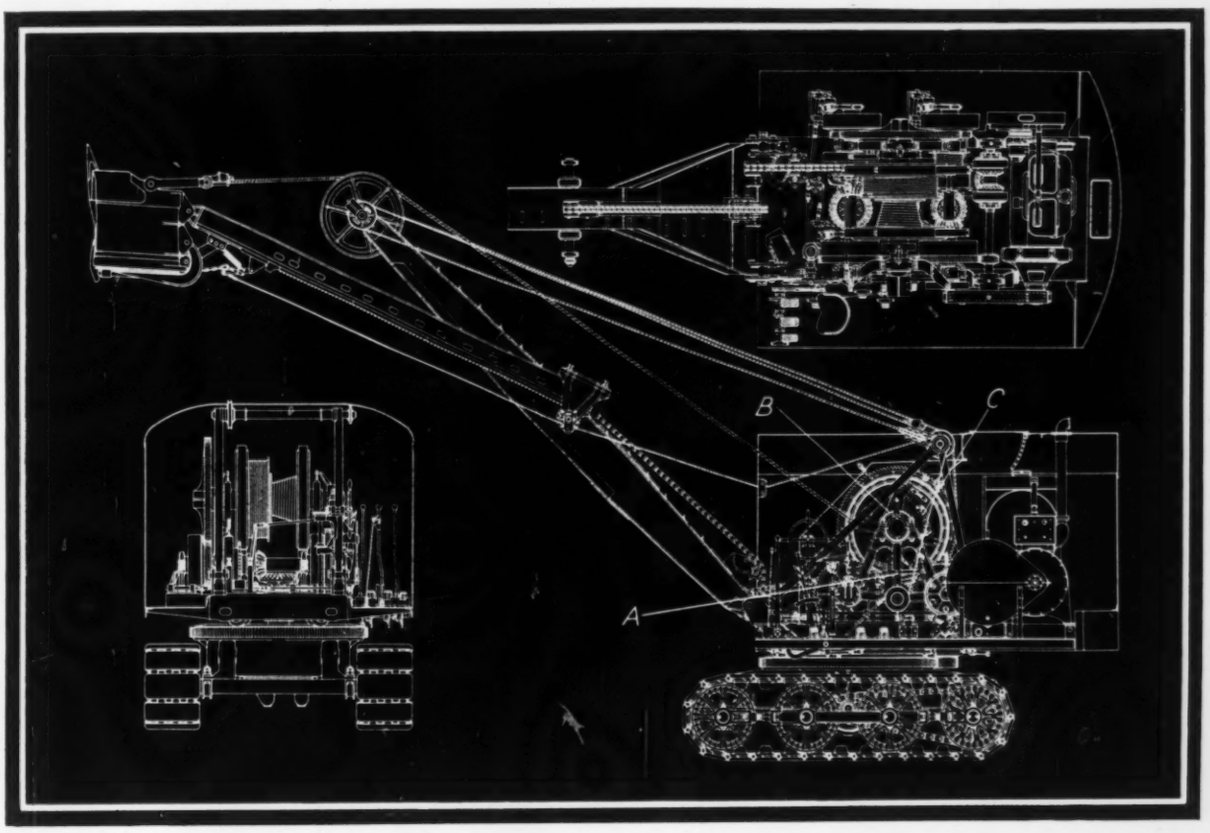


Fig. 2—Design details of this shovel reveal the degree of compactness which has been attained

O. Engineers engaged in creating machines for other types of work undoubtedly will be interested in some of the factors involved in the development of this shovel.

Cushioning effect in the various driving arrangements is obtained by the employment, on each of the four principal shafts, of two opposed clutches—the two on the forward shaft for use in traveling or crowding, two on the main shaft for operating the two drums, two on the rear shaft for swinging, and two on the jack shaft for raising and lowering the boom. All these clutches are of the internal expanding type.

Toggle Facilitates Ease of Control

Operation of the drum clutches, Fig. 4, is accomplished by power from the drive shaft through a small auxiliary brake. Arm *C* in Fig. 4 is drawn inwardly to expand the clutch band when the operator shifts the control lever to tighten the band *B* of the brake through the leverage shown in Fig. 3. The toggle *A*, Figs. 3 and 4, makes it unnecessary for the operator to hold the control lever to retain engagement.

Standardization has been one of the aims in the design of the shovel. Exemplary of this is the fact that the four swing, crowd and propel clutches are duplicates and are interchangeable. This also holds true for the two drum clutches as well as for the two boom clutches.

Employment of a single line hoist for the shovel offers many advantages over the two or three-part hoist customarily employed. Given sufficient engine power, its use eliminates the padlock sheave at the dipper and therefore permits a higher lift. Inasmuch as the speed of this cable is only half what it would be for a two-part hoist, the length of cable wound on the drum likewise is only half. This makes possible the use of a narrow drum, permitting the distance between shaft bearings to be materially lessened and affording more free room in the cab. The drum employed in connection with this single line hoist is tapered, providing for the greatest power when the dipper is digging and allowing speed to be gained when the dipper comes out of its work.

Large Drums Minimize Rope Wear

While large diameter drums always have been considered the ideal in shovel design, the difference in rope speeds necessary for convertibility from a dragline to a clamshell and vice versa more or less held designers to the use of small diameter high speed drums. The recommended minimum diameter for drums and sheaves is 30 times the rope diameter, or a 30-inch drum for a 1-inch wire rope. In the shovel under discussion this specification is met by the use of interchangeable lagging. When the present design is converted to dragline, clamshell or lifting crane it is possible to increase the drum size, by applying larger lagging, to 32 or more times the rope diameter. This has effected considerable economy in operation and in the life of the wire cables.

In the development of this unit large drums were an outstanding aim. Instead of following the customary practice of working out the power plant and designing the machine forward to the drums, the drum diameters desired were established first and from there the design worked back toward the power plant. It was found that contrary to all former theories, this practice lent itself to even more compactness of the machinery.

Balance and stability are imperative in this type of equipment. This is obtained by reason that all of the machinery is located to the rear of the center pin. Employed for the crawler truck frame is a one-piece annealed steel cast-

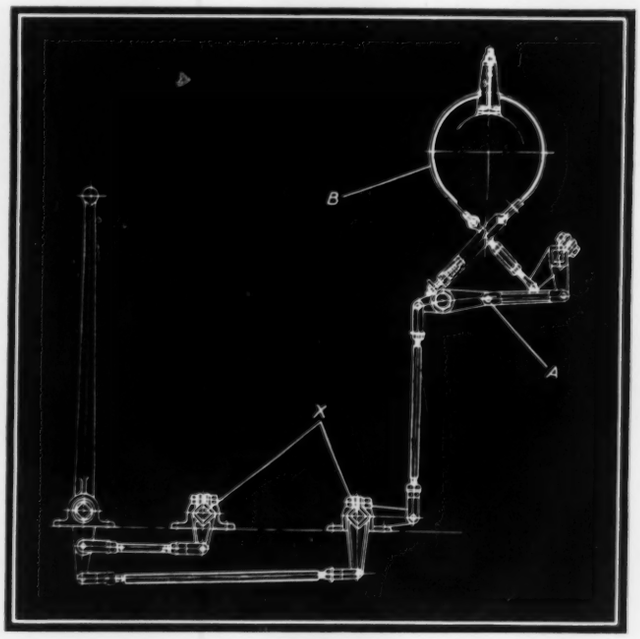


Fig. 3—Employment of square shafts and toggle joints insures positive action of the control mechanism

ing with supports and gearcase cast integral. Ten bolts hold the gear for rotating the superstructure rigidly in place. Machined on top of the gear is a wide path for the rollers on which the superstructure is mounted. The freedom with which this can be rotated, even though weighing 60,000 pounds, is indicated by the fact that a man pushing on the side of the dipper can revolve the entire upper structure.

The center shaft is made of alloy steel, heat treated, and operates through the bronze bushed center journal. To eliminate lost motion and backlash it is splined at its upper end for receiving the bevel gear, and at its lower end for the double bevel gear which affords the two speeds for traveling. All other drive shafts on

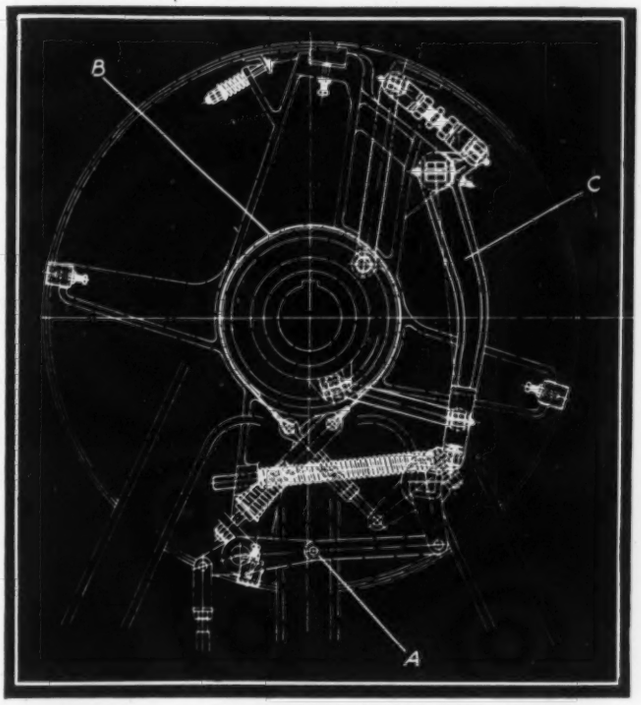


Fig. 4—The auxiliary brake sets in operation the mechanism of the internal expanding clutch of the rope drum

which are mounted sliding members are splined to obviate the possibility of vibration due to wear and backlash.

In the crawler truck the entire weight of the machine is supported on four stationary axles on which revolve four large track rollers on either side. Crawler treads are supported around these rollers and are driven by the rear roller through a sprocket chain. Either crawler tread may be thrown out of commission by the operator in the cab, allowing the machine to turn in a wide radius, or one can be locked to effect a sharp turn in its own radius. Provision for taking up the wear in the treads and drive chains is made in the adjustable side bars on the outside of the rollers. These bars are easily accessible and also form an outboard support for the four axles. Another feature characterizing the flexibility of the unit is the method of lengthening the crawler truck when increased bearing surface for the crawler treads is required. By uncoupling the tread, adding the necessary sections and installing another wheel in each end of the crawler unit, the extension can be effected without dismantling the machine.

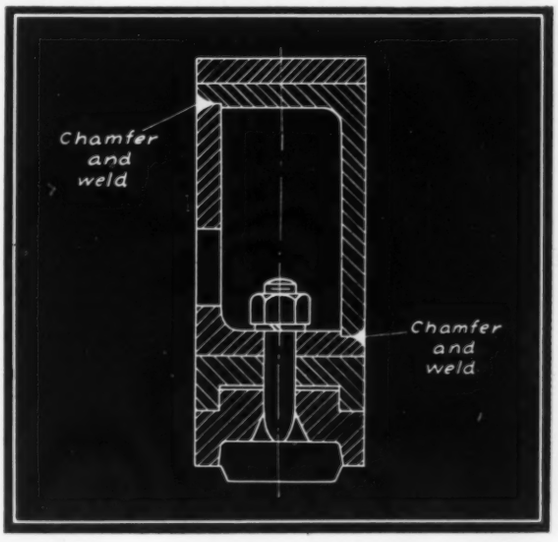


Fig. 5—Welded construction is employed to produce a strong box-type beam for the dipper handle

Construction of the dipper handle, which is of the two-arm type, is of interest. Each arm is made up of two angles welded together at the corners and forming a box section, to which is attached the necessary racking. Details of this design are shown in cross section, Fig. 5. The boom, of box construction, is composed of pressed steel members. Number of rivets used has been reduced to the minimum.

In selection of metals every effort was made to use as much standard material as possible, and for that reason large unit steel castings are employed throughout. The use of alloy steel has been limited to the shafts, gears, and some necessary forgings.

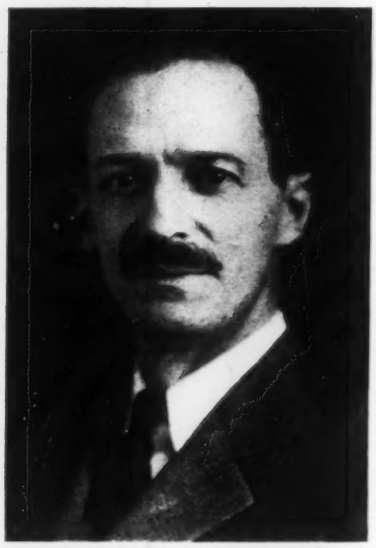
Square Shafts Eliminate Lost Motion

To insure positive and instantaneous response to the control mechanism, all levers and knuckles, instead of being keyed to round shafts, which usually is standard practice, are broached out square and slotted for clamping on square shafts by draw-bolts. These square shafts and broached levers are shown at *X*, Fig. 3. By this method the minimum of lost motion is assured in the control mechanism during the life of the machine. All controls are within easy reach of the single operator, who has full and unobstructed view of the machinery as well as the work being done.

The unit is finished in a distinctive combination of colors—the boom, machinery and truck being black, the lower half of the outside of the cab being painted a bright red, and the upper half aluminum. Inside of the cab is finished in white and provided with electric lights, supplied from the self-starter batteries on the engine. Gear ratio from the 900 R. P. M. engine to the drum shaft is approximately 60 to 1, and to the final drive on the crawler truck about 120 to 1.

During experimental and manufacturing development of the shovel, daily reports were sent in to the factory covering the operation of units placed purposely in different types of arduous service. Major changes in design were found unnecessary but many minor improvements resulted.

Treats Vibration in New Volume



A. L. KIMBALL
Author of "Vibration Prevention in Engineering."

Vibration Prevention in Engineering, *by Arthur L. Kimball; published by John Wiley & Sons Inc., New York; available through* MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

Perhaps no one phase of engineering is receiving more attention in the design of modern machinery than elimination of vibration. Various aspects of the subject have been treated in recent issues of MACHINE DESIGN, and almost concurrently a new book by Arthur L. Kimball of the General Electric research laboratory augments the data available to designers. The volume is intended as a reference work for practicing engineers and particularly for the students in the advanced course in engineering given by the author's company.

Purpose of the data is to give in concise form a resume of the factors which play a part in vibration prevention in engineering. Because it is impossible to do effective work in this field without some grasp of the fundamentals on which the subject is based, the book is recommended as one of the works which all design engineers should read. Mr. Kimball's method of presentation has been to develop each topic in a way which leaves no questions as to the basic logic involved, but at the same time to omit long analytical developments not essential to this understanding.

By clear visualization of theory and directness of attack on practical problems, the value of the presentation has been enhanced. Typical chapters deal with turbine wheel vibrations, balance of rigid rotors, prevention of noise and vibration through elastic suspension, shaft whirling due to internal friction and to oil action in journal bearings, and measurement of damping constants of solid materials.

The Internal Combustion Engine, *by D. R. Pye; published by Oxford University Press, New York; available through* MACHINE DESIGN *for* $4.00 *plus* 15 *cents postage.*

Principles which underlie design and operation of internal combustion engines constitute the point of view from which Mr. Pye has written his new book. It is intended for the engineer to study before he becomes involved in the intricacies of manufacture. Although dealing with principle rather than practice the data aims nevertheless at providing the groundwork of a practical knowledge of the subject.

One particularly interesting chapter covers detonation, also known as "knocking" or "pinking." The occurrence of detonation is much bound up with questions of engine design but recent research has shown that essentially it is a chemical and physical problem. Tables and diagrams are used extensively by the author in illustrating and clarifying his text.

Motion and Time Study, *by Allan H. Mogensen; published by McGraw-Hill Book Co. Inc., New York; available through* MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

In the capacity of editor Mr. Mogensen has woven together a wealth of data on the subject of motion and time study. Some of the material included is not new; however, as Mr. Mogensen says, if the manner in which the subject is presented enables those in the field to start where Frank B. Gilbreth, pioneer in the field, left off, they will have added to the present store of knowledge considerably more of both the principles and technique.

Chapter 15 is of particular interest to designers inasmuch as the relation of motion study to machine design is discussed. Instances are cited where study of machine operation has resulted in simple changes in some cases and in others complete redesign—done to improve the efficiency of the equipment. One of the most valuable instruments employed in this type of work is the camera. Motion pictures of operators tending their machines often tell an amazing story. The amount of benefit the designer can gain from a careful camera-aided analysis of his machine is incalculable.

Fig. 1—(Right)—Torsional deflection forces on a bar. Fig. 2—(Below)—Spring coils begin at loops

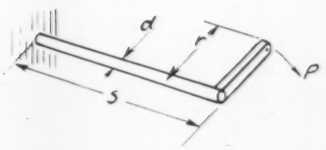
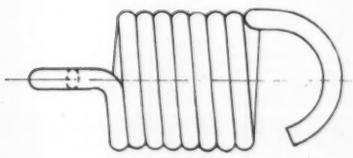
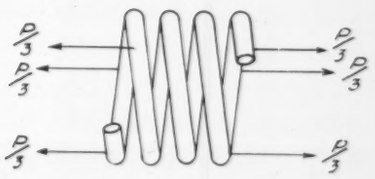


Fig. 3—(Below)—Three forces spaced 120 degrees apart give accurate check on deflection in the end coils





Spring Design Must Take Into Account Inactive Coils

By R. F. Vogt

ALTHOUGH the torsional modulus of elasticity has been known to be a quantity proportional to the tensional modulus of elasticity and to be characteristic for the material, and therefore constant for any material within its elasticity range, doubt still exists as to its value in connection with helical springs. In comparing calculations of helical springs with actual test performance, the torsional modulus of elasticity G for spring steel may range from below 10,000,000 to 12,000,000. Frequently 10,500,000 is chosen as the correct value. However, $G = 0.392E \doteq 0.4 \times 30{,}000{,}000 \doteq 12{,}000{,}000$. The difference in this value always is found when an error is made in the assumption of active coils in a given spring. The number of active coils as used in the deflection formula for helical springs does not always equal total number of coils or number of free coils. In most commercial helical compression springs the number of active coils must be more than the number of free coils, if we assume $G = 11{,}700{,}000 \doteq 12{,}000{,}000$.

The actual number of active coils for various helical spring designs and applications may be determined in accordance with the following views. Torsional deflection of a bar subjected to a torque Pr complies with the formula.

$$f = r\omega = 32r^2SP/\pi d^4G \quad (see\ Fig.\ 1)$$

in which

r = radius torque
S = length of bar
d = diameter of bar
P = load applied at radius r
G = torsional modulus of elasticity
ω = total twist angle of bar
f = deflection at end of radius r

For spring steel

$G = E \doteq 2\ (1 + 1/m)$
$E = 30{,}000{,}000$
$G = 11{,}700{,}000$
$m = 3.65$

These values correspond to the values given in

DUE to the torsional displacement between cross sections of the helical spring bar or wire in the so-called dead or inactive coils on each end of the spring, the total deflection of the spring is more than the deflection of the free coils. Mr. Vogt, assistant chief engineer, Allis-Chalmers Mfg. Co., analyses this problem in the accompanying abstract of a paper presented at the recent American Society of Mechanical Engineers' annual meeting in New York.

Huette, 26th edition. Transferring the formula for adaptation to helical springs,

$$f = r\omega = \frac{32\, r^2 \times 2r\pi \times n \times \cos a \times (P/\cos a)}{\pi d^4 G} = \frac{64 n r^3 P}{d^4 G}$$

in which

a = pitch angle
n = number of active coils

On some kinds of springs n, the number of active coils, can be accounted for easily; on others, including the largest number of commer-

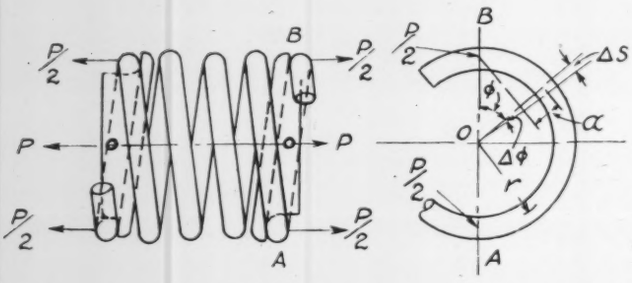


Fig. 4—Load is applied by yokes which reach diametrically from one side of the spring to the other

cial springs, n is not directly apparent. In a helical spring where the ends of the bar are connected solidly to a rigid radial lever reaching to the center of the coil where the load is applied, the active coils extend from lever to lever and equal the total number of coils. The same is the case in expansion springs with loop ends; the active coils begin and end at the loops if the loops join directly the cylindrical part of the coils, Fig. 2. In helical springs where the full length of bar is within the cylindrical part of the spring, as is the case on commercial helical compression springs and also on many kinds of expansion springs, the number of active coils extends beyond the number of free coils—i.e., the points of innermost support of the coil. Torsional deflection of the bar changes from maximum in free coils to zero in end coils. Torsional de-

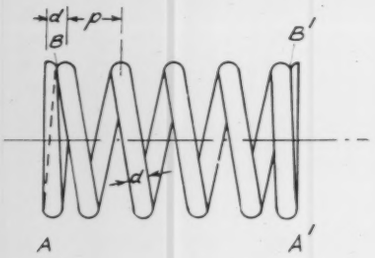


Fig. 5—Basic design of spring gives full bar action in end coil

flection within the end coils adds a certain amount to total deflection of the spring. This can be determined in many cases with absolute accuracy and in all other cases can be approximated accurately enough to satisfy practical applications.

To illustrate deflection effect of the end coils, we assume an open wound helical expansion spring on which load is applied by means of yokes on each end reaching diametrically from one side of the coil to the other, Fig. 4. Load P is applied at the middle of the yoke by means of a pivot so that each end of the yoke transmits the same pull, $P/2$, on the spring. As shown in the beginning, the effect of the pitch angle eliminates itself in the deflection formula, and we may assume the end coil to be in a plane vertical to the center line of the coil, and the forces vertical to the plane of the coil. We consider the torsion in any differential section $\triangle s$ of the bar between points A and B. The moment acting on the differential $\triangle s$ is

$$M = (P/2)a = (P/2) \times r\ (1 - \cos\phi)$$

The angle of twist in $\triangle s$ is $\triangle\omega$

$$\triangle\omega = 32\, M \times \triangle s/\pi d^4 G$$

$$\triangle s = r\triangle\phi$$

$$\omega = \int_0^{\pi} \triangle\omega = \int_0^{\pi} [32\ (P/2) \times r \times (1 - \cos\phi)\ r \times \triangle\phi\ ]/\pi d^4 G$$

$$\omega = \frac{16 r^2 P}{\pi d^4 G} \int_0^{\pi} \triangle\phi (1 - \cos\phi) = 16 r^2 P/d^4 G$$

Center o will have a total deflection of $f' = r\omega = 16\, r^3 P/d^4 G$ of the end coil due to force $P/2$ at B; force $P/2$ at A does not contribute to torsion in the end coil. This deflection corresponds to the deflection of ¼ coil subjected to the moment Pr. The same occurs at end $A'\,B'$, so the total deflection of spring is

$$f = 2f' + f'' = 2\ (16 r^3 P/d^4 G) + 64 n r^3 P/d^4 G$$

or

$$f = [64(n' + 1/2)\ r^3 P]/d^4 G = [8(n' + 1/2)\ D^3 P]/d^4 G$$

where

n' = number of free coils

In Fig. 3

$n' = 3\text{-}1/2$

$n = n' + 1/2 = 4$

If we apply three equal forces spaced 120 degrees apart as in Fig. 3, we find that deflection of the end coils is

$$f' = \frac{32(P/3) r^3}{\pi d^4 G} \left[\int_0^{4\pi/3} \triangle\phi\ (1 - \cos\phi) + \int_0^{2\pi/3} \triangle\phi (1 - \cos\phi) \right]$$

$$= \frac{32(P/3) r^3}{\pi d^4 G} \left[4\pi/3 + \sin\ (4\pi/3) + 2\pi/3 + \sin\ (2\pi/3) \right]$$

$$= [32 \times (1/3) r^3 \times 2\pi]\ /\ \pi d^4 G = [64\ (1/3)\ r^3 P]\ /d^4 G$$

For this condition the deflection of each end coil equals that of 1/3 coil under full torque of Pr. In this manner we can proceed with increasing the number of equal forces, evenly spaced around the end coil, and find that the deflection of each end coil corresponds to a deflection of full loaded coils as follows:

Number of equal forces acting on end coil	Space between these forces	Number of full-active coils necessary to produce same deflection as	
		One end coil	Two end coils
2	180	1/4	1/2
3	120	2/6	2/3
4	90	3/8	3/4
5	72	4/10	4/5
6	60	5/12	5/6
n	$360/n$	$(n\text{-}1)/2n$	$(n\text{-}1)/n$

Other load distributions show that $3 \times P/3$ is

the extreme derivation from $2\times P/2$ to be expected and that $2\times P/2$ is closest to the actual load distribution of most practical applications. Suppose part of load P is acting on A and the rest of the load is distributed equally for ½ circle from A over C to B, so that the resultant is in 0 (no load is possible between A and D as the coil leaves the spring end surface at A, D being the tip of the tapered end coil). The load per length unit along ACB being p, we find

$$p r\pi\ (r + 2r/\ \pi) = Pr \qquad p = P/r(2 + \pi)$$

$$\text{load on arc } ACB = r\pi p = P \times [\pi/(2 + \pi)] = 0.612\,P$$

$$\text{load in } D = P\,[1 - \pi/(2\ + \pi)] = 0.388\,P$$

The resultant of load on arc ACB and on D is in 0, as shown in the foregoing. For $3\times P/3$ distribution load in A would be $0.333P$; $0.388P$ being larger than $0.333P$ proves that the distribution shown in Fig. 6 is closer to $2\times P/2$ loading than the $3\times P/3$ loading and that the error would be considerably less than 1/12 coil if the $2\times P/2$ loading should be substituted for Fig. 6 loading. It is evident that for practical purposes only the first and second load condition can be considered, and that the first predominates in actual spring applications (see Fig. 4). For compression springs forces are applied in the opposite direction; deflection is also in the reversed direction, but calculations and results are otherwise the same. The design and application of a commercial helical compression spring are such that the load condition ranges between the first and second case given above, the first condition predominating.

Full Bar Section Used

The foregoing calculations are based on full bar cross section in end coil. This supposition is conformed to by most commercial compression springs, for that part of the coil which must be considered in the calculation. The basic design of the spring is shown in Fig. 5. The ends of such a spring are closed, ¾ of the end coil is tapered from full cross section to ¼ thickness at the end, the pitch changes at contact point B from p to d. Full cross section of bar is maintained from B to A, suggesting a load division of $P/2$ at A and $P/2$ at B. The possible variation from this load division cannot be much, and surely cannot come within the range of the three point loading of $3\times P/3$ (and shown by load distribution in Fig. 6), in which extreme case the difference would correspond to 1/3—1/4 = 1/12 coil for each end correction.

The resultant of these forces is in the center line of the coil. If it should fall outside the center line, the spring would bend out sidewise, which in most compression spring applications does not occur to any appreciable amount. Within the range of the free coils, i.e., from B to B', Fig. 5, the bar is subjected to a shear force equal to $P/2$ and a torque equal to Pr. In a well-applied compression spring torque Pr is uniformly the same all along the bar, P acting in line with the center line of the coil. Due to the fact that the length of contact between the end coils increases slightly during increase in deflection, thereby effecting a slight decrease in active coils, the assumption of $2\times P/2$ load division is more justified, as the error in allowing a little less active coils than would correspond to actual possible different load distribution is compensated by the tensity of slight decrease in active coils

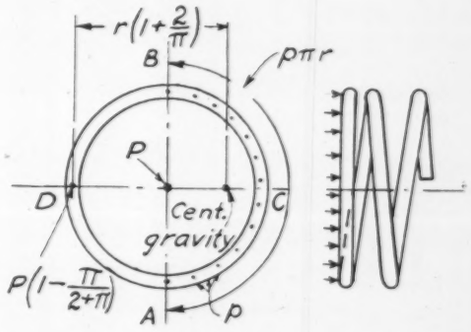


Fig. 6—Distribution of loading as it is applied to a compression spring

during compression. It is therefore logical and practically correct to choose the $2\times P/2$ load division, for which case the effect of the end coil is equal to the effect of ¼ active coil. The total number of active coils for a helical compression spring, therefore, may be taken as the number of free coils (coils between contact points B) plus ½ coil. The deflection of a helical compression spring of the shape shown in Fig. 5 is:

$$f = 64\,nr^3P/d^4G = [64(n' + 1/2)\,r^3P]/d^4G$$

A large number of tests have proved this contention, and it also has been found that G approximates 11,700,000 for any size and kind of spring steel bar.

Requires Large Quantities of Mercury

MERCURY required to operate the new 20,000-kilowatt mercury turbine just installed at the Kearny station of Public Service Corp. of New Jersey and a similar installation at Schenectady, both made by General Electric Co., represents about 89 per cent of the mercury consumed by the United States in an average year. Each installation requires 270,000 pounds of mercury. The institution of mercury vapor generating systems forecasts a new and highly significant factor in the mercury or quicksilver market. Present production in the United States is about 12,000 flasks a year, each flask containing 76 pounds. The amount of metal in these two installations would supply about 50,000,000 ordinary thermometers, the commonest use of mercury.

Editorial

Reduction in Capital Costs Should Be Aim in Current Design

IN THE turmoil of today's discussion of technological unemployment, almost everyone has jumped to the conclusion that the primary motive of designers of machinery is to create something that will save labor or put men out of jobs.

It is time, of course, that conditions during the past several decades have furnished a strong incentive for developing labor-saving machinery. Reducing the number of man-hours of productive labor per unit of product has been and will continue to be a challenge to machine designers.

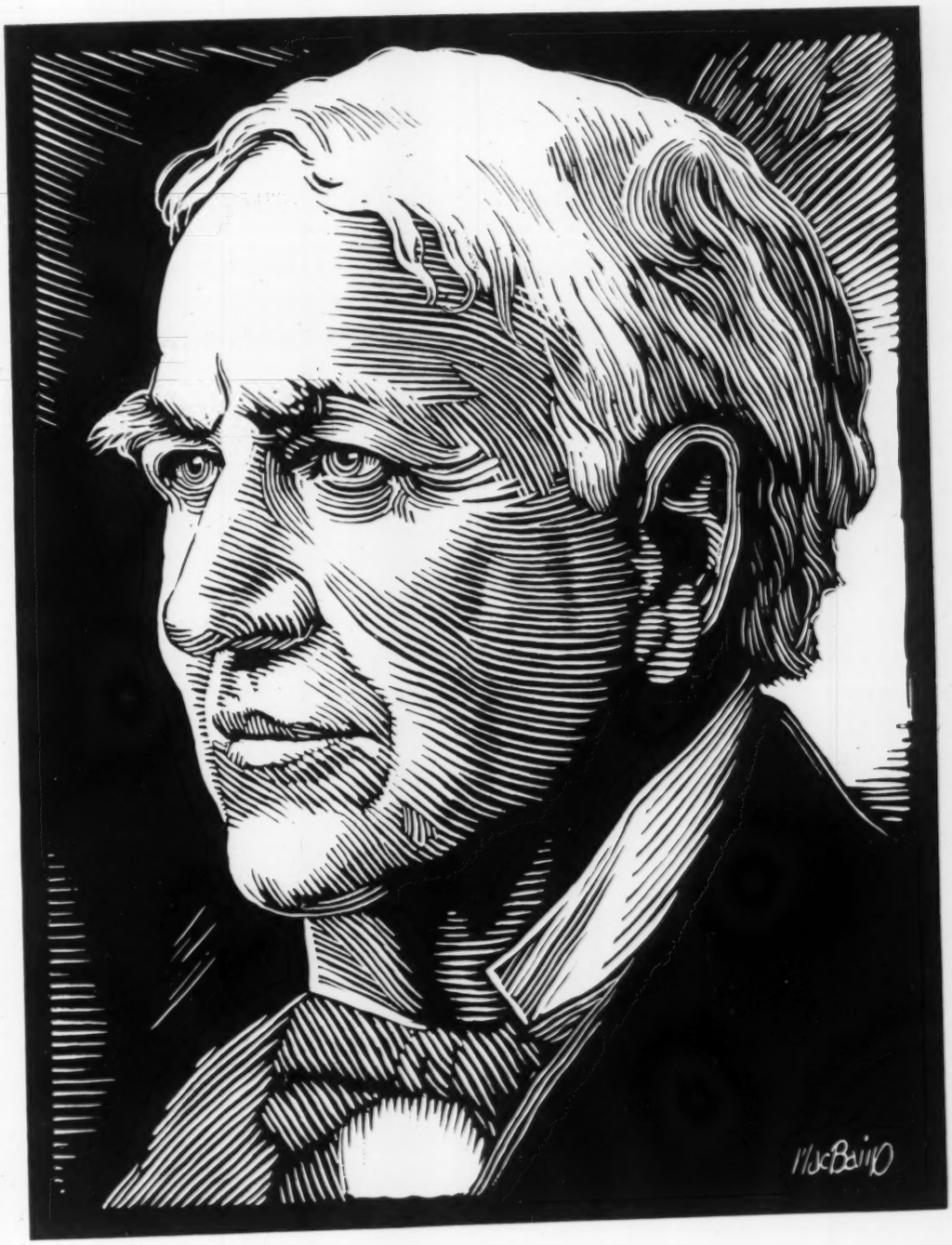
But it is a grave mistake to assume that economy in labor is the only major objective in design. A recent development in the rolling mill industry promises to produce a finished steel product of high quality but at only a fraction of the capital expenditure for plant and equipment required formerly. It is doubtful whether this mill will effect any savings in the use of labor. However it affords such marked economy in the use of capital that it promises to win prompt acceptance in the rolling mill industry.

Efficiency always will be the dominating motive in design, but whether the major emphasis lies in efficiency of time, labor, capital, material, cost of operation, floor space or other factors will depend upon the circumstances prevailing at the moment. Right now economy in the use of capital would seem to be an appropriate objective for designers.

Machining with the Flame!

WILL present machining methods, as far as certain materials and forms are concerned, be obsolete in the near future? Among the latest developments to come to light in this respect is one which involves employment of the oxyacetylene flame. "Flame machining," the name by which the process is known, shows unusual possibilities. Research work has been in progress for some time, and it now transpires that flame planing for instance, instead of machining with the conventional planer tool, can be carried out at astonishing speed. Turning, grooving, centering, drilling, etc., also have been accomplished satisfactorily.

One result of progress in this direction, as brought out by a speaker at the recent International Acetylene association's meeting, may be the redesign of some machine tools and design of others to utilize flame machining. Much remains to be done before this is likely to happen, but the possibility should be kept in mind both by machine tool builders and other designers alert to take advantage of new developments in production methods.



Thomas A. Edison

Master Designers

Thomas A. Edison

INVENTORS have been originating ever since Adam took the first crude step to improve his comfort, but never has the world seen an inventor who devised and improved more devices than Thomas Edison. No other man holds the same distinction of inventing the equipment for an entire industry. This erstwhile itinerate telegrapher, born at Milan, O., in 1847, was granted over 1150 patents, including patents for all of the basic devices used in the electric light industry.

EDISON'S taste did not run to mere discovery, he was vastly more interested in new development of practical nature. He covered every field of endeavor where he could visualize a need. His patience was colossal; ten years was spent in search for the secret of the storage battery; the world was scoured for the proper material for a light filament. Included among the mechanisms and processes he designed or improved are:

Dynamos	Wire drawing	Crushing machinery
Generators	Cement kiln	Submarine detectors
Phonograph	Vote recorder	Telephone diaphragm
Typewriter	Moving pictures	Multiplex telegraph
Mimeograph	Magnetic mining	Multiple arc lighting
Dictaphone	Storage battery	Electrical instruments
Light bulbs	Call box system	Plate glass manufacture
Vacuum pump	Concrete houses	Manufacture of chemicals
Stock ticker	Electric railways	Automatic telegraph relay
Torpedo boat	Synthetic rubber	Acid writing for the blind

IT HAS been estimated that his inventions are worth 16 billion dollars to the world, yet this still does not reflect his amazing ingenuity. Every invention was, in fact, a series of inventions, and his discoveries would have made him the inventor of the telephone, microphone and wireless telegraphy if he had followed all of them up. Never inactive, Edison was granted 40 patents in the last 12 years of his life, a lifetime's work for many distinguished men. He died at 84. One of his most widely used though less scientific compositions is not generally credited to him; he coined the word "Hello," in daily use on millions of telephones.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Will Pay for Letters or Solutions to Problems Suitable for Publication

Determining Safe Beam Loads

To the Editor:

DIFFICULT calculations necessary in determining the safe load which can be imposed on a beam of irregular cross section are so laborious and have caused so much trouble that I would like to offer a simple graphical solution which will permit accurate and rapid determination of the moment of inertia of a beam. Once the moment of inertia and the section modulus are found, calculation of safe load reduces to a routine procedure. The graphical method is sufficiently accurate for all practical purposes if the drawing is made carefully to scale. The steps in this solution are as follows for one of the simpler beam shapes.

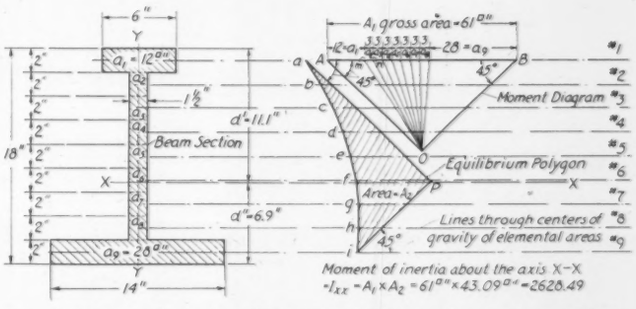
Draw the beam section as at the left in the accompanying illustration full size (or to scale) and divide it into any convenient elementary areas; the larger the number of these the more accurate will be the result. Compute the area of each (or measure it with a planimeter) and through the center of gravity of each elementary area draw a center of gravity line.

Now proceed to draw the moment diagram, upper right, by laying off accurately to scale on center of gravity line No. 1 the areas of each elementary area to a lineal scale, commencing at *A*. The length of this line, *AB*, will equal numerically the gross area of the whole section, which in this case is 61 square inches. Draw lines from *A* and *B* at 45 degrees to center of gravity line No. 1. These lines will intersect at some point *O* which is the pole of this diagram; to this draw the radial lines from each elementary area point.

Next draw the equilibrium polygon *api*, commencing at *a* on center of gravity line No. 1 and drawing the 45-degree line as shown, also from *a* draw the line *ab* parallel to line *mO* in the moment diagram, ending on line No. 2; draw *bc* parallel to *nO*, and so on till *i* is reached on the last center of gravity line, here shown as No. 9. From *i* draw the 45-degree line intersecting the other and locate the pole of this figure. This pole always falls on the line of the center of gravity of the whole section here marked as the *X-X* axis and may be projected on to the beam section. In this case the axis falls 6.9 inches from the base of the section.

Now measure the area of the equilibrium polygon *api* with a planimeter, or in any other manner that is accurate, and secure the area A_2. In this case we find it to be 43.09 square inches.

We now can compute the elements of this section namely: the moment of inertia about the



Graphical solution simplifies calculations when using a beam of irregular cross section

neutral axis $XX = I_{xx} = A_1 \times A_2 = 61 \times 43.09 = 2628.49$ inches^4; the section modulus for the upper half $= S_u = I/d' = 2628.49 \div 11.1 = 236.8$ inches^3; and for the lower half $= S_l = I/d'' = 2628.49 \div 6.9 = 380.9$ inches^3.

After drawing a few diagrams of various sections in this manner, one may become quick and expert at this method. For irregular and complicated shapes it is much preferred to any analytical computation, and is considered safer. There is less probability of an error occurring as any error is almost sure to be found immediately by the diagrams not closing properly; and the planimeter reading of A_2 can be checked.

—F. W. SALMON,
Richmond, Va.

Insuring Efficient Braking

To the Editor:

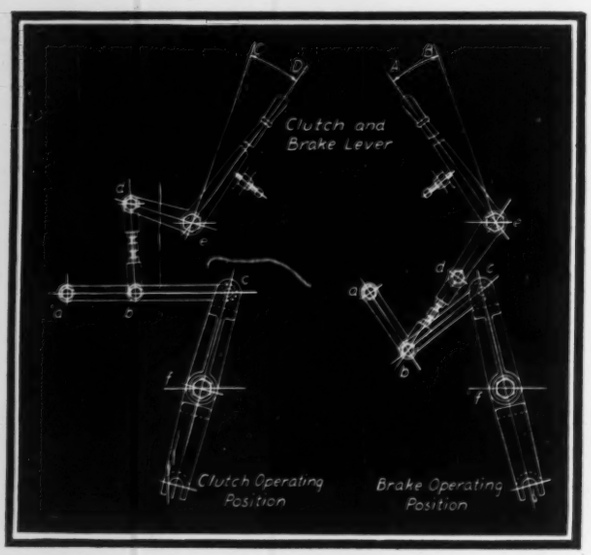
IN A heavy duty clutch and brake unit, where one unit was used as a clutch and another similar unit on the same shaft served as a brake,

considerable trouble was experienced in the units spreading due to the constant banging of the lever being thrown. This spreading caused the clutch and brake to become out of adjustment frequently. In addition, when a heavy load was imposed on the clutch it often became disengaged. To solve this problem the designers evolved a mechanism which may be of use to others.

To remedy both of these conditions a mechanism similar to the one shown in two positions in the accompanying diagram was used. It consists of three links, one being adjustable, and two levers. One link pivots at *a* and the levers pivot at *e* and *f*.

When the clutch is thrown in, points *a*, *b* and *c* form a straight line and cannot be broken over-center except by the operator. This prevents the clutch from disengaging under load, and the clutch yoke cannot go over any further than the combined length of the two links—at which point the clutch is adjusted to be run.

When the clutch is thrown out and the brake



Lever mechanism prevents clutch or brake spreading under heavy shock loads

applied, from the angular distance *D* to *C* there is a mechanical *force* advantage of 2.5.

From *C* to *B* there is a mechanical *throw* advantage of a similar amount but through this distance little force is required as the clutch has been disengaged and the brake does not begin to be applied until point *B* has been reached; there the *force* advantage again occurs from *B* to *A*.

When the brake is applied *b*, *d* and *e* form a straight line holding the brake applied until the toggle is broken over by the operator.

This mechanism is comparatively simple, yet it prevents separation of the clutch and brake units through constant shock, and also prevents the clutch or brake from becoming disengaged except at the operator's election. In addition, these links provide a mechanical advantage on each end of stroke at the point where the force is needed most.

—Lloyd A. Whittaker,
North Attleboro, Mass.

Create Bushing Standards!

To the Editor:

Inasmuch as the present bushing standards are little more than a collection of stock sizes and since they cover only the sleeve type of bushings, it would be of great help to designers if a well worked out and complete bushing standard could be formulated by the bushing manufacturers as a whole or by the American Standards association.

A bushing standard should cover the major dimensions and tolerances of sleeve, split, collar and self-aligning types and in addition the details of oil grooving. Standards for physical and chemical properties of bearing materials have been drawn up by the Society of Automotive Engineers and the American Society for Testing Materials, while a number of bearing manufacturers have their own standards for materials. These material standards should be revised and incorporated in the proposed bushing standard as a part thereof.

Machine designers would welcome such a standard. It would eliminate the necessity for detail bushing drawings, which now are required for all types of bushings other than the plain sleeve. A bushing standard also would reduce manufacturers' production costs because of the greater number of bushings of each size produced.

If bushings were standardized, many manufacturers would stock them in the various materials in which they specialize. Hence the designer of machines would have available to him economically, a larger variety of bearing materials than at present. Recently I had a need for a few graphited bronze bushings. A local manufacturer informed me that their graphited bronze bushings were made by a process that did not lend itself to the economical manufacture of the quantity of bushings desired. If standardized, these bushings probably would have been made in quantities for stock and hence my requirements could have been met economically.

Manufacturers of ball and roller bearings have given the designer the load carrying capacity of their bearings under various condi-

tions of service. Would it not be of great assistance to the designer if bushing manufacturers did likewise? The load carrying capacity of the various bushing materials is not too well known and handbook data on this subject is far from complete. Tabular information of the load carrying capacity of the different bushing materials under the various service conditions would be the natural outgrowth of a bushing standardization program.

Any interest you may be able to create within those bodies which should formulate a bushing standard would be appreciated.

—ARTHUR J. STOCK,
Rocky River, O.

Eliminating Drawing Confusion

To the Editor:

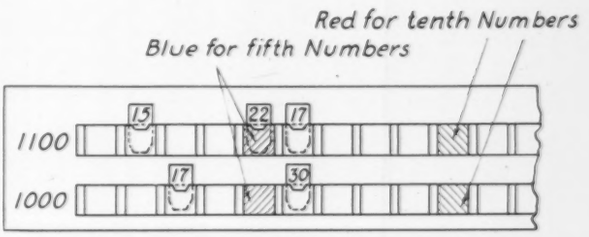
DESIGN department operation problems such as the one outlined by M. W. Elmendorf in the October issue are of pertinent interest to all engineers. This discussion brings to my mind a problem along these same lines. The difficulty of finding drawings in the design department is one which has irritated every designer at one time or another. The problem consists mainly in overcoming lack of orderliness, selfishness, lack of consideration of the rights of others, or a sense of superiority to justifiable rules and regulations.

Type of system depends on quite a number of factors such as number of men employed, whether or not the drawings are allowed to circulate freely or only to a limited amount, also whether or not designers are allowed to remove drawings from the filing drawers themselves.

In one office the charging out of drawings is achieved by using a wall rack of small pockets, each numbered to correspond with a drawing, into which a small ticket is slipped as a drawing is issued. The slip bears the number of the man who took out the drawing. The rack shown in the accompanying illustration is made of close-grained light cardboard. Each draftsman has about thirty of the tickets and section leaders have more according to requirements. With 150 men in the organization the scheme works well with a filing vault personnel of only two boys.

The type of work is such that drawings of greater age than three years almost invariably become obsolete, except as a matter of record. The numbering system is consecutive so that the wall chart or rack always can be kept within a reasonable size. In a wall space 70 by 40 inches, about 3000 drawings can be indexed in this way. In the office under discussion, each complete unit of design required about 400 drawings of individual pieces so that a rack of the size mentioned takes care of six to eight designs.

With this system the attendant can determine quickly if a drawing is in file or, if not, to



Wall chart detail for assisting in locating drawings quickly in design department

whom it is charged. This eliminates much handling of drawings in the drawers which would be necessary if a search were made there for the drawing each time.

The wall rack must be kept up to date with the new drawings being made. This is done by subdividing decimally and labelling only the main thousands and hundreds divisions, while suitable colored marks denote the tenth and fifth numbers. Little effort is required on the part of the attendants. An additional index indicates the names of the men in the department corresponding with the numbers issued to them on the tickets.

—W. S. BROWN,
Auburn, N. Y.

Calculator Simplifies Drive Selection

CALCULATION of the units involved in a V-belt drive is simplified by a new instrument which instantly selects the ideal drive for any installation. Tables, slide rule, etc., are eliminated as a turn of the instrument dial gives specifications for the drive immediately. All answers are given in actual figures or words and no scale reading or setting is necessary. In addition, the calculator incorporates all the data usually included in handbooks issued by manufacturers.

Information given includes the diameters of the driver and driven wheels, number and size of ropes, choice of center distances with rope for each and exact horsepower of the drive. If there is a choice of several drives which can be used, specifications for all of them will appear on the dial. All irrelevant data is kept out of sight. Further information on the calculator may be obtained from Allis-Chalmers Mfg. Co., Milwaukee.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

MEMBERSHIP of the board of directors of the American Standards association, now includes Dr. Lyman J. Briggs, acting director of the bureau of standards. He represents the United States chamber of commerce. In addition to his duties as head of the bureau Dr. Briggs is acting chairman of the federal specifications board and of the national screw thread commission.

Since college days he has been in the service of the government. When the United States entered the war in 1917 Dr. Briggs was detailed by executive order to the bureau of standards and was assigned to problems in the field of aerodynamics and ballistics. During this period he developed with J. F. Hayford, a gyroscopic instrument for maintaining an artificial horizon below deck as an aid in directing gun fire from battleships. Those instruments now are installed on many of the battleships of the navy.

In 1920 Dr. Briggs was made chief of the division of mechanics and sound of the bureau of standards and in 1921 received in collaboration with P. R. Heyl, the Magellan medal for a new earth inductor compass for use in aircraft. He also made a special study of the characteristics of airfoils held in air streams moving at speeds as great as that of sound, which provided information applying directly to the design of aircraft propellers. In 1926 he was appointed assistant director of the bureau of standards and became acting director on the death of Dr. George K. Burgess in July of this year.

FOR his paper on "Equivalent Circuits," presented at the past winter convention of the American Institute of Electrical Engineers, Frank M. Starr recently received the Noble prize. The gift which was established in 1929 in the memory of Alfred Noble, a prominent engineer in the half century preceding 1914, stipulates that the recipient must be under 30 years of age. The award is confined to members of the four founder engineering societies and the Western Society of Engineers.

At his graduation from the University of Colorado in 1928, Mr. Starr received the degree of bachelor of science in electrical engineering. In July he entered the service of General Electric and spent one year on test, which was followed by a year in the general engineeering department. For the past two years he has been a member of the central station engineering department.

The award is confined to members of the four founder engineering societies and the Western Society of Engineers. Selection of the individual who is to receive the honor is made by a committee including one representative of each of the five organizations.

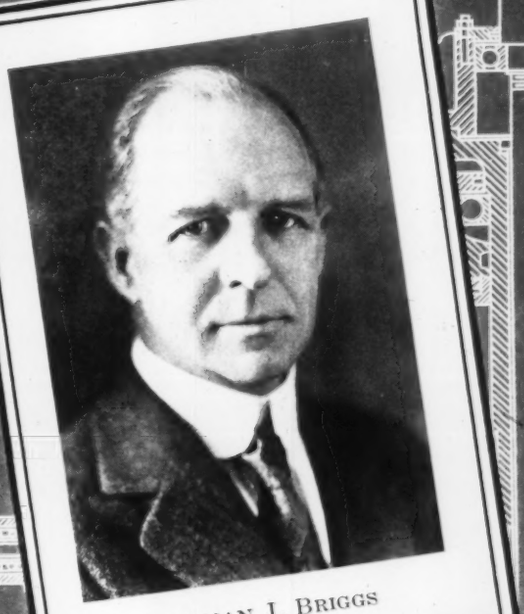
PIONEER in the develcpment of organic accelerators which speed up the vulcanization of rubber, George Oenslager has distinguished himself as an outstanding chemical engineer in the rubber industry. His work has brought about longer life to all rubber products, a factor which has increased the value of this substance as an engineering material. For his achievement Mr. Oenslager has been awarded the coveted Perkin medal, which will be presented to him early in January.

Born September 25, 1873, in Harrisburg, Pa., Mr. Oenslager obtained his early education there. Later he matriculated at Harvard with the ambition, he confided later to associates, of becoming a second Edison. He became so engrossed in chemistry, however, that he forgot his earlier ideas. After graduation in 1894 he took a post graduate course, obtained his master's degree, and then went into the pulp and paper industry where he remained fcr ten years in research.

May 1905 found him in the laboratories of the Diamond Rubber Co. and a year later he started work to find a means by which cheaper wild rubbers could be made to vulcanize as rapidly as those of higher grade. The result was his discovery of organic compositions as accelerators of vulcanization—with an estimated savings of at least $50,000,000 a year tc motorists alone.

NOTABLE industrial achievement in initiating mass production of copper from low grade ores through application of engineering principles, recently won the 1933 John Fritz

Leaders in Design, Engineering and Research



LYMAN J. BRIGGS

FRANK M. STARR

GEORGE OENSLAGER

DANIEL C. JACKLING

gold medal for Daniel Cowan Jackling. As a result of his pioneer work many billions of pounds of copper have been added to the world's potential reserves.

A native of Missouri, but now a resident of San Francisco, Mr. Jackling holds executive positions in a number of companies. It was in 1899 while working at Mercur, Utah, after he had been graduated with a degree in metallurgical engineering in 1892, that he foresaw the possibility of reducing costs in mining and milling low grade copper ore by operating on a scale never before contemplated. He put into effect the idea of mining the ores occurring at or close to the surface with steam shovels, and of recoving the small copper content in concentrating mills far beyond the size of those which had been the usual practice.

Mr. Jackling has contributed in an outstanding way to the success of many lines of industry. A large supply of copper at reasonable prices has been fundamental to the development of all phases of the electrical industry, as well as to automotive design. A primary feature of his public work was his distinguished service to the government during the World war as director of explosives.

* * *

John Lyle Harrington of the consulting engineering firm of Harrington and Cortelyou, Kansas City, Mo., and John H. Gregory, consulting engineer, Baltimore, have been appointed by President Hoover on the board of engineers which will pass upon the engineering phases of construction projects on which the Reconstruction Finance Corp. has received applications for loans.

* * *

Dr. Irving Langmuir, associate director of the General Electric research laboratory, recently was awarded the Nobel prize in chemistry. A picture and biographical sketch of Dr. Langmuir appeared in the April issue.

* * *

W. A. Hillebrand, formerly electrical engineer for Ohio Insulator Co., division of Ohio Brass Co., recently accepted a professorship in electrical engineering at the University of California.

* * *

Lewis S. Reid, formerly chief engineer of the Magnetic Analysis Corp., has joined the staff of Lucius Pitkin Inc., as associate metallurgist.

* * *

Dr. Willis Rodney Whitney, organizer and for 32 years director of the research laboratory of General Electric Co., retired November 1 from that position because of poor health. He was succeeded by Dr. William David Coolidge, senior associate director of the laboratory. Dr. Whitney continues as vice president in general charge of research. Biographical sketches of Dr. Whitney and Dr. Coolidge appeared in the April, 1931, and March, 1932, issues of MACHINE DESIGN respectively.

* * *

R. C. Bret, formerly affiliated with Trundle Engineering Co., Cleveland, and for the past year engaged in special engineering work for the Glidden Co., recently has been appointed director of engineering for the 21 plants of the latter company, with headquarters in Cleveland.

* * *

Victor J. Cucci, consulting engineer, formerly of the firm of Kimball & Cucci, and William A. Brown, consulting engineer, have announced the opening of offices for practice of engineering under the name of Cucci & Brown Inc., New York.

* * *

Oliver Smalley, president of the Meehanite Research institute for the past three years, was re-elected to that post at the recent annual meeting of the organization in Cleveland. A picture and biographical sketch of Mr. Smalley appeared in the May, 1931, issue.

* * *

C. M. Burrill has resigned his position as research engineer with the Rogers-Majestic Corp. Ltd., Ontario, Canada, to return to the R. C. A. Victor Co. Inc., Camden, N. J., where he will be connected with the research division.

* * *

F. J. Rudd has been appointed managing engineer of the motor department of the General Electric Co. He succeeds L. E. Underwood, who has been made manager of the Pittsfield, Mass., works of the company.

* * *

James I. Clower, formerly affiliated with the Vacuum Oil Co., New York, as technical editor, now is assistant professor of machine design at Virginia Polytechnic institute, Blacksburg, Va.

* * *

W. S. Shipley, president York Ice Machinery Corp., York, Pa., is the new president of the Refrigerating Machinery association.

* * *

F. W. Vigelius and Russell Johnson have joined the teaching staff of the mechanical engineering department at Michigan College of Mining and Technology, Houghton, Mich. The former was with Ingersoll Rand Co. for about eight years, serving in the inspection, produc-

tion, research and machine design departments. Mr. Johnson formerly was chief draftsman of the O. E. Zekely Corp., Holland, Mich., and later held the same position with Comet Engine Corp., Madison, Wis.

* * *

P. C. Clarke, formerly in charge of spring design at the Philadelphia works of General Electric, has been placed in charge of the engineering and research departments, Hunter Pressed Steel Co., Lansdale, Pa.

* * *

H. E. Rosebrook has accepted a position in the engineering department of the Gibson Electric Refrigerator Corp., Greenville, Mich. He comes from Springfield, Mass., where he was connected with Westinghouse for several years.

* * *

E. J. Rutan, supervisor of the test bureau, New York Edison Co., has been reappointed chairman of the American Institute of Electrical Engineers committee on instruments and measurements.

* * *

Fraser Jeffrey, electrical engineer, Allis-Chalmers Mfg. Co., Milwaukee, recently was elected president of the Engineers' Society of Milwaukee.

* * *

D. W. McLenagan has been appointed assistant engineer of the commercial engineering division of General Electric's air conditicning department.

* * *

L. C. Stowell, president of Dictaphone Corp., Bridgeport, Conn., recently was elected president of the Equipment Manufacturers' institute.

* * *

J. B. Fisher, chief engineer, Waukesha Motors Co., Waukesha, Wis., has been elected a director of the company.

* * *

J. J. Donovan, manager of the air conditioning department, General Electric Co., was elected a director of the American Oil Burner association at the recent regular quarterly meeting of the board of directors.

* * *

Gen. Thomas S. Hammond, president of the Whiting Corp., Harvey, Ill., has been nominated for the presidency of the Illinois Manufacturers' association. Gen. Hammond's picture and biographical sketch appeared in the June issue.

* * *

Fred H. Dorner, mechanical engineer, Milwaukee, and vice president of the American Society of Mechanical Engineers, has been appointed alumni representative on the board of visitors of the University of Wisconsin. A picture and biographical sketch of Mr. Dorner appeared in the Feb., 1931, issue.

Obituaries

TINIUS OLSEN, 86, known internationally as a designer and manufacturer of testing machines, died at Philadelphia, October 20. Born at Kongsberg, Norway, he was educated in various schools in his native land. In 1869 he came to the United States, becoming a draftsman for William Sellers & Co., Philadelphia. At a Lutheran Sunday school he became acquainted with brothers named Riehle, and for them designed his first testing machine. In 1872 he became identified with Riehle Bros., but in 1879 he founded his own business. At various expositions he won prizes, and was decorated by the King of Norway. To his native city of Kongsberg he made many benefactions. A son, Thornsten Y. Olsen, has been associated with him in business.

* * *

V. G. Apple, the inventor who installed the first electric lights on automobiles and was a pioneer in the development of self-starters, died recently at Dayton, O. He was the owner of 200 patents and 100 others that had expired. The Apple Electric Co., which he organized to manufacture his automobile starters, was sold in 1914 to the Splitdorf Electric Co.

* * *

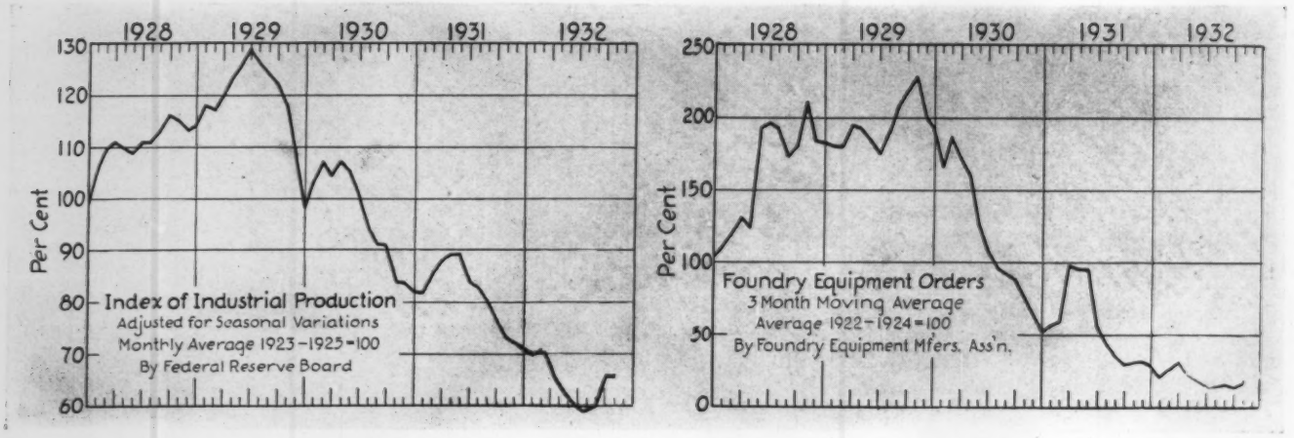
John Ripley Freeman, consulting engineer and president of the American Society of Mechanical Engineers in 1905, died recently aged 77 years. He was graduated from Massachusetts Institute of Technology in 1876.

* * *

Samuel Amdursky, consulting engineer and in charge of the mechanical department of the Taylor Instrument Companies, Rochester, N. Y., died recently after a short illness. He was 40 years of age. In 1915 he was graduated from the college of engineering of Syracuse university and formerly was associated with the Rochester Gas & Electric Corp.

* * *

Hans Luthi, general plant superintendent, Nash Motors Co., Kenosha, Wis., died recently from the effects of an operation. He was born in Switzerland, September 28, 1880, came to America in 1902 and gained recognition as an expert in automobile engine and transmission design and production.

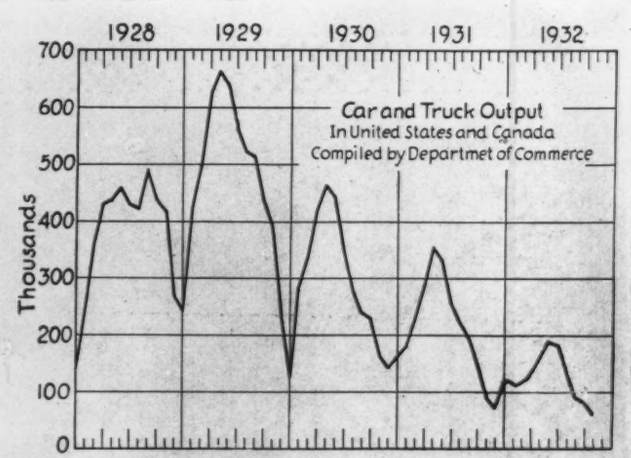


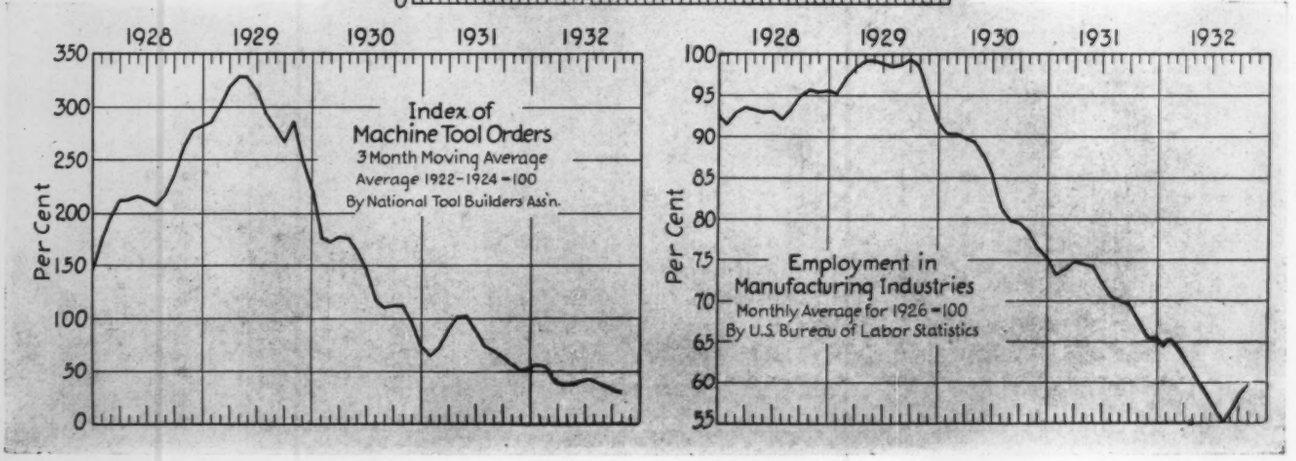
How Is Business?

INDICATIONS of improved sentiment, that most important business commodity, are given in a survey conducted by National Association of Manufacturers which shows that 76 per cent of the companies reporting believe prospects for the winter as good or fair, contrasted with 50 per cent a year ago. Such a reaction from companies among the first to sense the trend is of the most encouraging type.

The report also indicated that 62 per cent of the companies found their own business to be good to fair at the present time as compared with only 50 per cent who experienced this degree of activity a year ago. Improvement of this type has been reflected to some degree in business indexes and is undoubtedly the basic factor in the recent rise of industrial production and employment figures as they apply to manufacturing industries.

The improvement has lost some of the acceleration manifested in September and early October, but the recessions that have occurred in several important lines of business are clearly seasonal. A good example of this type of recession is the figures for freight car loadings which touched a high point in mid-October and then receded rather rapidly. However, this recession was not unexpected as these figures have declined during this season in the best business years on record. In fact, the current cycle was the basis for considerable optimism as the curve continued upward later into the fall than heretofore and downward acceleration was slower.





NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

RUBBER as an engineering material again asserts its importance in design, this time in the form of a sleeve to provide an effective governor for a fluid motor. The invention, patented by John R. Hoffman for Madison-Kipp Corp., Madison, Wis., is applied particularly to pneumatic tools such as grinders, Fig. 1. The governor, designated patent No. 1,886,546, prevents racing of the tool and possible breakage.

In Fig. 2*A* parts of the governor which include rubber sleeve 71, are in inoperative position, while *B* shows the parts expanded to throttle the turbine when it exceeds its predetermined maximum speed. Studying the operation of the entire unit, Fig. 1, it will be seen that exhaust from turbine runner 34 passes into barrel 11 and flows normally both around and through the governor unit on its course to the exhaust outlet at the outer end of the casing.

In practice the annular space, 89, Fig. 2*A*, serves merely as an operating clearance between protector sleeve 69 and the casing. Consequently this space is slight and permits the passage of only a small amount of air. On the other hand annular space 88 is much larger so as to allow free passage of exhaust fluid from the turbine runner and operation of the grinder spindle at full operating speed.

Sleeve 71 of the governor is made of specially cured rubber and all parts of the governor are dimensioned properly so that the spindle and attached parts may revolve up to a predetermined speed without the governing device functioning to reduce the speed. As soon as the spindle 33 exceeds this maximum speed, however, the increased centrifugal force imparted to the rubber sleeve causes the free portion to expand or stretch, thereby gradually cutting down and finally closing off entirely the annular space 88 when the rubber sleeve contacts with the interior of protector sleeve 69 as shown at *B*, Fig. 2. Expansion of rubber sleeve 71 also seals the annular series of openings 87 and passage of exhaust fluid beyond the governor is prevented, except for the small

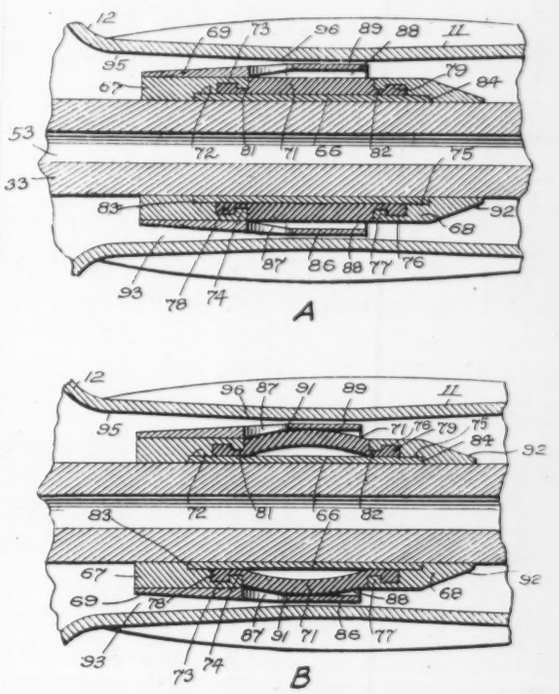


Fig. 2—Details of the rubber and protector sleeves of governor, the parts being expanded at B

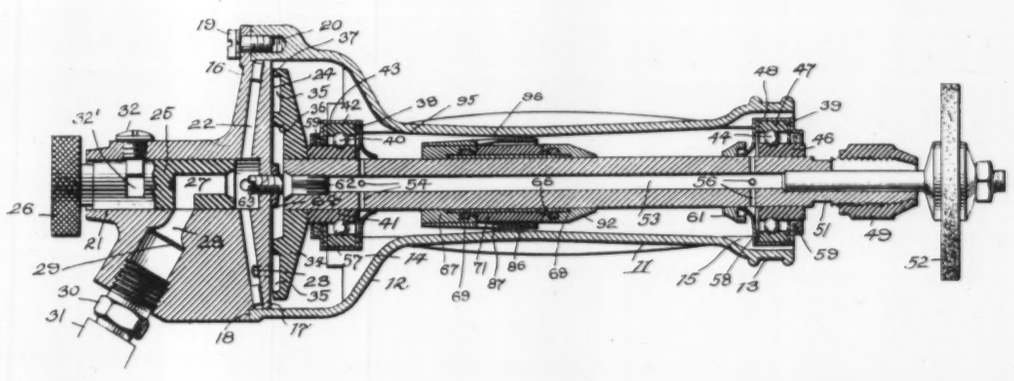


Fig. 1 — Pneumatic grinder employs governor embodying rubber sleeve which is controlled by centrifugal force to prevent racing of the tool and possible breakage

amount that escapes through clearance space 89. This is insufficient to drive the rotor at a suitable operating speed. When the spindle slows down the rubber sleeve of course assumes its normal shape. Outer sleeve 69 serves not only to limit the expanding action of of sleeve 71 but it also protects the sleeve from damage and wear.

TO SUPPLY lubricant to the upper bearing surfaces of a vertically arranged bearing assembly an impeller has been utilized by William C. Graul. He designed the device for Timken Silent Automatic Co., Detroit, and holds

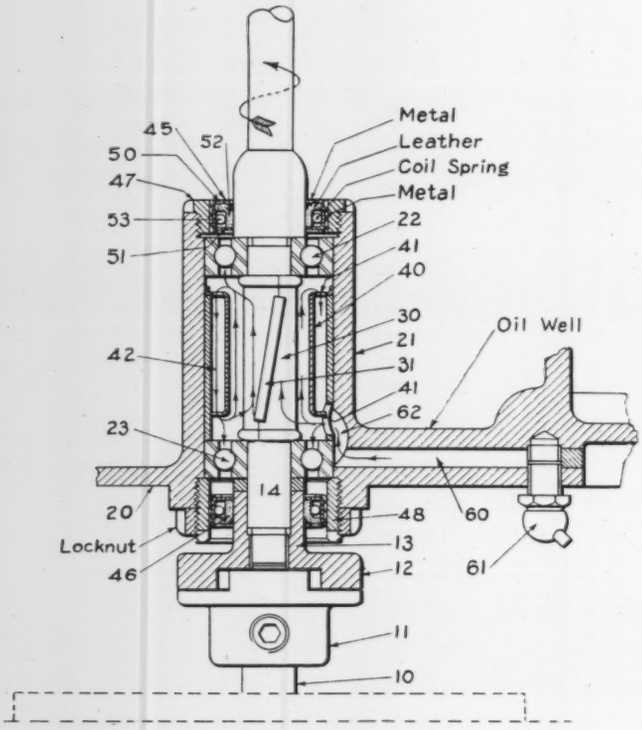


Fig. 3—Helically arranged impellers on vertical shaft pump oil to upper bearing surfaces of this assembly

patent No. 1,886,395 on it. The invention, Fig. 3, is adapted particularly to oil burners of the rotary type.

On shaft 14 between bearings 22 and 23 is a pump element or impeller 30 which embodies a sleeve having blades 31. These blades are arranged helically about the sleeve. The inventor prefers to make this part by blanking out and forming two halves, each with side flanges which when crimped or folded over serve the dual purpose of holding the parts together and forming two blades.

Within the body 21 is another sleeve 40, designated as a pump casing sleeve. This part 40 is supported in body 21 and spaced from the latter by means of end flanges 41 which are perforated to permit easy flow of oil between the sleeve 40 and part 21. Sleeve 40 is positioned within a short distance of the outer edges of blades 31, assisting in effecting the upward flow of lubricant when the shaft is rotated in the direction of the arrow, Fig. 3.

Inside the ring 51 is a flanged leather ring 52 which fits closely around shaft 14. Around ring 52 extends a contracting ring 53 of the coil spring type. Sealing rings employed are assembled as a unit and pressed into the threaded collars to form a tight fit. Lubricant is supplied to the sealed chamber through passage 60, entering by means of valve 61. The arrows indicate the passage of oil when the shaft is rotated.

DESIGN of packaging machinery abroad is progressing as indicated by the recent development of a German machine for automatically opening square bottom paper bags. This device recently was granted patent, No. 1,886,376 in this country. Xaver Dambacher is the patentee and the firm of Windmoller & Holscher, Lengerich, Westphalia, Germany, assignee.

Details of the machine are shown in Fig. 4. At the beginning of operation, guideway 28 raises and slides 26 and 27 approach each other moving to the right, Fig. 4 *A*, close to the vertical plane in which stops 80 are arranged. Lower ends of fingers 18 and 19 then are raised far enough to pass finger notch 74, *B*, Fig. 4, in one of the walls of the foremost bag 15 which touches stops 80. The other wall of the bag however is pressed slightly backward toward plate 16. At this point the bag is opened slightly.

In sequence, movement of slides 26 and 27 toward each other is effected by cams 40 and 41 and the train of levers so that fingers 18 and 19 are in contact with each other. Fingers 20 which were raised at the beginning of the working period approach each other and are lowered by cam 11. Cam 10 by means of lever 50, crank levers, spring 48 and suitable segments, rotates rods so that the attached levers enter the bag

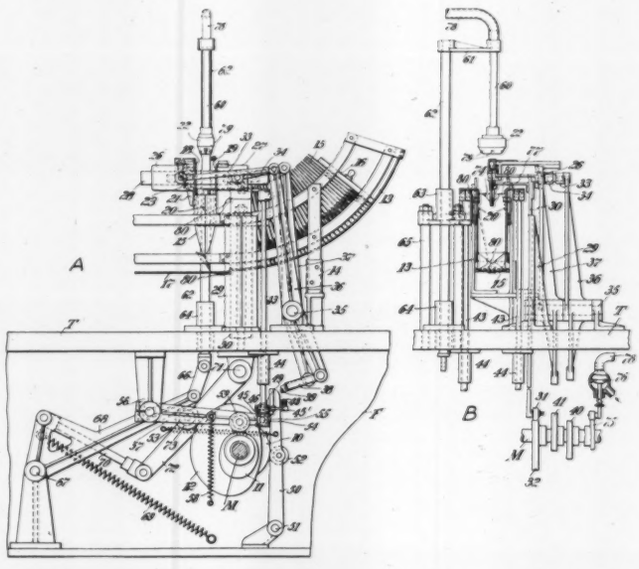


Fig. 4—Compressed air and lever mechanisms automatically open square bottom paper bags

opening and spreading out the folded tucks.

Immediately following this plunger 22 is lowered by action of cam 12. This plunger has a cross section similar to the inner section of the bag when filled, and is lowered close to the bottom. By employing compressed air delivered through holes 79 in the plunger head a complete spreading of the bag is insured. When the plunger has reached its lowermost position the cams come into action and start the various parts through a new cycle in which another bag is brought into place for opening.

IN COMBATING excessive expansion of clutch and brake parts due to heat generated by the certain amount of slippage that is desirable in

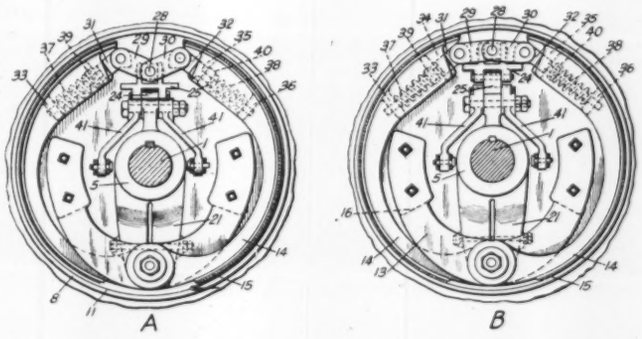


Fig. 5—Coil springs compensate for expansion of clutch parts when heat is generated in operation

operation, John D. McEwen has designed a clutch which incorporates resilient members to effect adjustment. The patent which recently was granted for the unit is designated No. 1,887,377 and the International-Stacey Corp., Columbus, O., is assignee. In Fig. 5 a side elevation of a pulley structure with the clutch as a part, the expanding band contracted, is shown at *A*, and a similar view with the band in expanded position is depicted at *B*.

Springs are employed to compensate automatically for the changes in temperature which result should the clutch be slipped during a hoisting operation, generating enough heat to cause expansion of drum 8. Coil springs 37 and 38 being under compression, Fig. 5 *B*, will cause the band section to follow the drum as it expands. Thus no manual adjustment is necessary to compensate for these changes in temperature and the apparatus readjust itself automatically as the temperature returns to normal.

The band is made up of two sections which are pivoted on the same pin. At one end these sections are spaced apart and can be expanded by a toggle lever mechanism; at the other end they extend beyond the pivot pin upon which they are mounted and are provided with counterweights which act centrifugally during idle rotation of the clutch to facilitate disengagement and to prevent dragging and accidental braking or clutching action of the band.

Splash Lubrication Fails at Subcritical Speed

(*Concluded from Page* 28)

safety. Substitute the value of R in equation (2) and solve for N.

$$R = \tfrac{1}{2} \text{ of } 1\text{-}\tfrac{1}{2} \text{ ft., or } \tfrac{3}{4}$$

$$N^2 = \frac{2935}{\tfrac{3}{4}} = 3920$$

$$N = 62+$$

Thus we conclude that splash lubrication will be maintained at 62 revolutions per minute and over, but will become uncertain and cease in proportion as we drop below that speed.

Suppose the low speed shaft must run at 25 revolutions per minute—what diameter must the gear be to supply satisfactory splash? Substituting in equation (2) the result is 9.4 feet. In most cases this dimension would be out of good proportions, so two expedients are open: One of the secondary gears may be employed as a splasher, or a set of scraping troughs may be supplied to the low speed gear so arranged as to scrape off the oil from the sides of the gear and lead it to the various bearings, etc. Of course these scrapers should not actually touch the gear. Employment of such scrapers involves the use of troughs connecting with all bearings.

How should oil be introduced into roller bearings? When the bearing is of the type having long cylindrical rollers, the oil generally can be fed through a hole in the center of the outer race. It then will work out to the ends in both directions. Drains must be provided at each end to guarantee circulation, otherwise the oil will tend to back up into blind ends, and churn and heat.

With tapered roller bearings, oil should be introduced at the smaller end, Fig. 3, because this type tends to pump the oil from the smaller to the larger end. In some cases oil is splashed into the larger end with apparently satisfactory results, but in all probability there is sufficient oil mist present in such cases to prevent damage at the small end.

Ball bearings and short roller bearings of the cylindrical type may be lubricated generally from either side, but the best results are obtained when the circulation principle is adhered to. Lead a splash trough to one side and provide a drain to the case, at the other.

The scheme of lubricating gears from splash, and packing the bearings in grease, has been tried and abandoned long ago. It seems impossible to keep the two grades of lubricant separate. However, such progress has been made during the last few years with oil seals that it would not be surprising to find some enterprising designer revising this scheme with success.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

INVENTIVE minds of America are following new trends if records of the United States patent office are taken as a criterion. Certain types of devices are embraced in the applications in greater number, and at a time when total applications are declining at the rate of about 12 per cent over previous periods.

In the past year Commissioner Thomas E. Robertson notes that there has been an influx of applications for patents in connection with air conditioning, refrigeration, oil burners, dewaxing oils for automobile lubrication, alloys, electric clocks, the automobile industry and devices for rendering railroad travel more comfortable, safer and less expensive.

Many of the applications which have been received in increased volume represent the engineering talent of already established companies that wish to improve their products. Simultaneously, other applications reveal the ideas of American consumers. The commissioner points out that many of the patent applications on devices relating to railroads come from experienced technical railroad men, but also that there are applications springing from the brains of those whose only railroad experience has been as passengers. Such ideas sometimes lead the way to far-reaching changes, he declares.

* * *

Cites Value of By-products of Research

RESEARCH has made rapid strides in the past few years and is a particularly potent factor in raising the country out of the depression. Augmenting this much discussed topic Harry L. Horning, president, Waukesha Motor Co., Waukesha, Wis., emphasized the value of indireet results, collateral discoveries and the by-products of research in his recent talk before the Society of Automotive Engineers in New York.

Such by-products, he declared, in the majority of cases equal the primary objectives in importance and in many cases are of greater consequence. He described a case of research instituted to develop a cylinder iron that would not "grow" in service; from it more than 10 by-products resulted. Warning against the trend to go off on a tangent during research and the tendency to delay the finish, Mr. Horning said it seems that bringing a research problem to conclusion is the most difficult part of the task. Consequently most of the value is lost. When research is completed there usually is a psychological collapse which delays following through to the application of the idea. It is to be expected that practical men will be skeptical toward the results, and difficulty often arises in getting the market and the world in general to adopt the results of research.

* * *

Engineers Extend Co-operation to R. F. C.

LOANS applied for under the self-liquidating provisions of the emergency relief and construction act aggregate more than a billion dollars, according to the American Engineering council, which is organizing the nation's engineering profession to co-operate with the Reconstruction Finance Corp. in speeding construction projects contemplated by Congress.

Engineer activity is under way throughout the country following the appointment of 37 engineers as members of the advisory committees of the corporation's loan agencies. From now on, it is believed, the work of each of these agencies will be co-ordinated so effectively that the task of the engineers' advisory board of the corporation at Washington, to which all applications are submitted for final engineering approval, will be materially simplified.

Engineering assistance, it is planned, will expedite the disposal of applications already made and encourage a large number of new undertakings, particularly those involving small loans. Self-liquidating loans totaling $134,633,500 have already been approved. Engineers express confidence that there soon will be a large increase in loans of this type, with a resultant sharp gain in employment and manufacturing activity before winter is far along.

* * *

Report on Extended Lubrication Research

CHEMICAL mechanism of lubrication was discussed by William F. Parish and Leon Cammen at the recent annual meeting of the American Society of Mechanical Engineers in New York. Their introductory paper on the subject of the mechanism of lubrication, ab-

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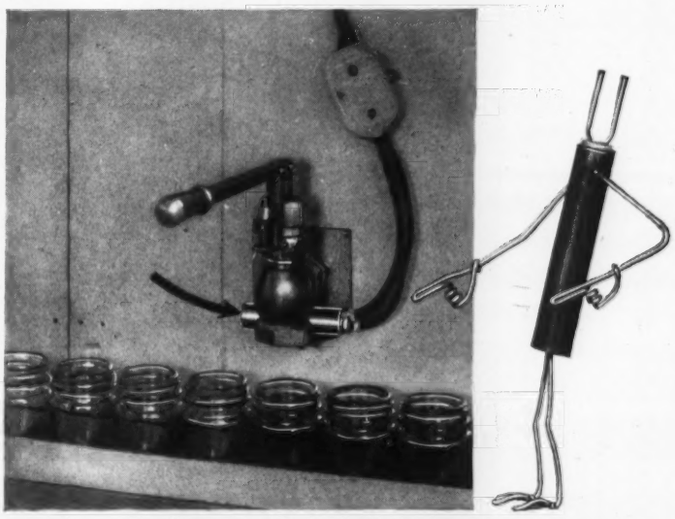
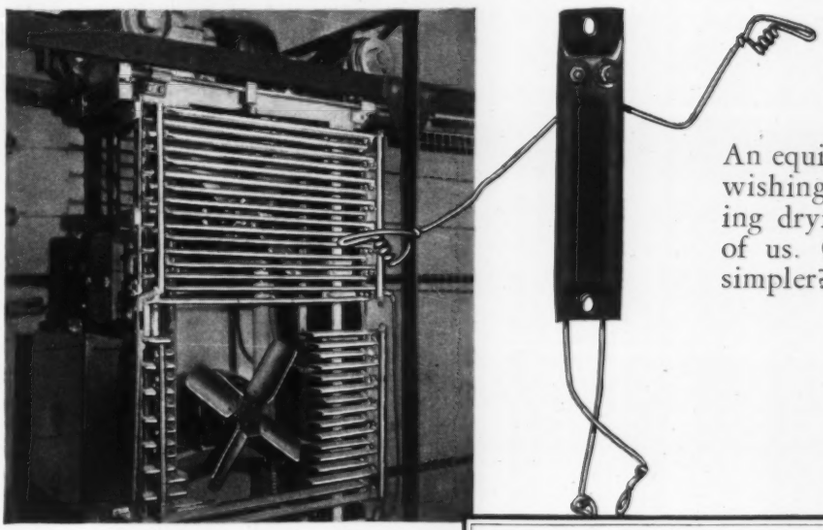


I am *"Spot"* (a G-E cartridge-type electric heating unit)

See how I solved a problem for this pharmaceutical manufacturer. This valve is used to fill jars with ointment. A spot of electric heat inserted behind the valve keeps the ointment at proper viscosity. Could anything be simpler?



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GENERAL ELECTRIC

stracted in the August issue of MACHINE DESIGN, attracted attention not only in this country but abroad as well. In the new paper the authors point out that while mechanical engineers design lubrication systems, lubrication as such is essentially a chemical phenomenon.

Explanation in terms of electric fields is given as to why excessive heat is developed when a dry shaft runs in a dry bearing. New criteria for testing of lubricants is established in the paper which also lays a practical foundation for future research in the field of manufacture of lubricating oils and their application in modern machinery.

The practical part of the paper discloses for the first time how during the World war the lubrication of Liberty engines and other aircraft was improved tremendously by a retreated lubricant. The same lubricant later was tested in diesel engines, automobile and special equipment, giving unusual results. These data are being submitted in view of the fact that they seem to substantiate from a practical point of view the phenomenon described. This is of more than ordinary interest as it indicates the possible development of lubricants of much greater efficiencies.

* * *

Farm Machinery Exports Gain, Output Drops

FARM implement exports are showing a steady rise in their relation to production in this country, from 10 per cent in 1920 to 27 per cent in 1931, a depression year. In 1929 American production of farm implements entered the 10 per cent class in export trade. While output declined during the next three years the percentage of exported implements increased to 12 per cent during 1921, to 13 per cent in 1922 and to 15 per cent in 1923. During the following four years these exports remained fairly constant or around 20 per cent for each year. By 1930 foreign countries took 24 per cent and last year when production dropped to its lowest level, the export trade in these implements rose to 27 per cent of American production.

* * *

Educational Work in Welding Increases

INDICATIVE of the ever-increasing field for engineers versed in welding is a new combined practical and theoretical one-week course in designing for welded construction. This opportunity is being offered by John Huntington Polytechnic institute, Cleveland, in co-operation with the Lincoln Electric Co. The course will be repeated several times during the winter season.

Restricted to 30 men who must be graduate engineers or have equivalent practical experience, the course covers a week's intensive work, the six days being spent in the Lincoln operator's training school. Lectures on designing for arc welded construction will be given in the evenings at the Huntington institute.

* * *

Free Trade in Ideas Hurdles Tariff Walls

TO MAKE available to manufacturers in one country, devices, processes and patents that have proved successful in other countries, offices now have been opened in New York by Amerika-Interessen Inc., organized as the American unit of A. G. Fuer Amerika-Interessen, operating also in Berlin, Paris and London. The organization virtually is sponsoring free trade in ideas to surmount the tariff barriers which now gird the world.

According to the statement made by Botho Lilienthal, president of the corporation, the newly created unit will negotiate agreements covering production and marketing rights for manufacturers who wish to augment their incomes by obtaining business abroad but who can not do so by exports. This is accomplished by issuing licenses on a royalty basis or by the outright sale of manufacturing and marketing rights for the country involved. International trade of this type helps the unemployment situation of the country into which new ideas are introduced because it often opens new lines of manufacture in such countries and also is of financial benefit to companies in the country from which the ideas are exported.

* * *

Industrial Drama Gets Hearty Reception

WELL deserved comment has been invoked by an innovation in convention programs —the industrial drama presented at the recent thirty-third annual meeting of the International Acetylene association in Philadelphia. Titled "The Prosperity Process," it was enacted before 2500 guests and suggests one way of balancing top heavy technical programs.

The play deals with the experience of a typical manufacturing company during the present depression. For three years scarcely little business has been booked and then suddenly an order for 10,000 parts for an air conditioning system is received. The hero is the oxyacetylene process which affords the management not only means to repair its down-at-the-heels equipment with minimum expense but also a production tool for mass manufacture. So satisfactorily is the order executed that a repeat order for an even larger number of parts is received. Novelty of the industrial drama holds an appeal for thousands who have tired of meetings overburdened with ordinary technical sessions.

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Sales success is being largely determined in design departments these days. Performance must be so improved that buyers *can't* say "No." REEVES can help you. . . . Send for a copy of the 74-page REEVES catalog.

PARTIAL CONTENTS

List of 81 different types of production machinery in which the REEVES Variable Speed Transmission is incorporated as standard equipment.

Engineering data in convenient form for reference—tables for selecting correct size and class (speed range) of REEVES Transmission for any machine application. Complete dimension diagrams of various REEVES Designs, efficiency charts, etc.

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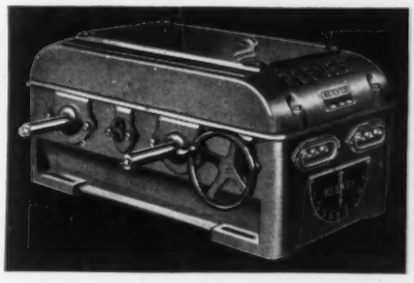
The processing of many different sizes of products on one machine; changes in composition or in the characteristics of material in process; variance in temperature or atmospheric conditions; changes in the complete production schedule; need for increasing or decreasing "cycle" operation of machines; variances in the number or skill of machine operators; changes in machine operation occasioned by new products, new designs or new sequence of processing.



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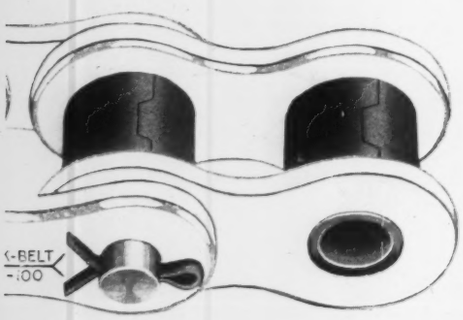
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

New Chain Resists Corrosion

SIDE bars of the new roller chain brought out by Link-Belt Co., Chicago, are especially treated to combat corrosion. This treatment gives them the appearance of silver. Silverlink roller chain shown herewith is made in all sizes from $\frac{3}{8}$ to 2½-inch pitch, and in single or multiple widths. It is available with wheels for any horsepower, also with conveying attachment links in wide variety. Complete drives are stocked in sizes up to 225 horsepower, in speed ratios of from 1:1 to 8:1.

Construction features include: Side bars of

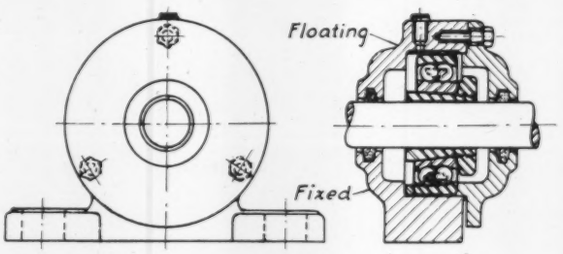


Side bars of new chain are especially treated to assist in resisting corrosion

alloy rolled steel heat treated for strength and toughness, and especially treated to resist corrosion; nickel steel case-hardened pins, detachable type with cotter or furnished riveted; solid steel case-hardened bushings; and alloy steel heat treated rollers.

Pillow Block Pedestals Are Compact

ADAPTABLE to all average industrial requirements, the new line of unit pedestals for pillow blocks announced by Norma-Hoffman Bearings Corp., Stamford, Conn., is available in sizes to fit standard shafting in nominal inch as well as sixteenth diameters from 15/16 to 3½ inches. The ball bearings in the unit, shown herewith, are the standard double row, self-aligning type with adapter sleeve manufactured by the company. The pedestals have capacity for a large volume of lubricant with fittings for replenishing as needed. Protecting felt seals prevent escape of lubricant along the shaft. These pedestals may be had with the bearings

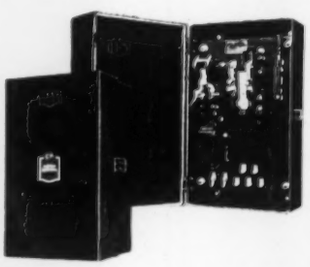


Protecting felt seals prevent escape of lubricant on pillow block pedestals

either floating or fixed in the housing. In the latter case suitable distance pieces are furnished for clamping the outer ring.

Starter Designed for Severe Service

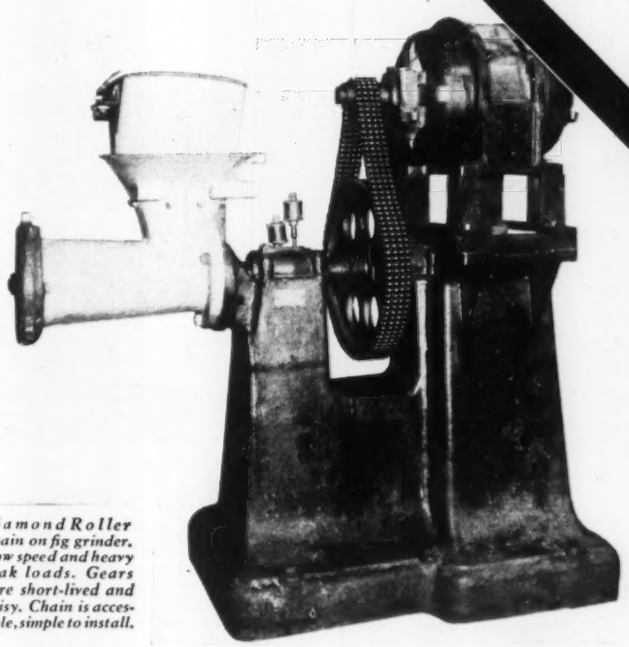
DESIGNED for use on equipment employing motors rated 15 horsepower and below, where starting duty is severe, a new across-the-line type, automatic motor controller has been brought out by Cutler-Hammer Inc., 328 North Twelfth street, Milwaukee. The unit, shown herewith, employs a simple adjustable means of timing to allow the field current of the motor to build up to full strength before the circuit to the armature is closed. This feature protects and saves the motor by cutting down the current inrush about 50 per cent. Over-



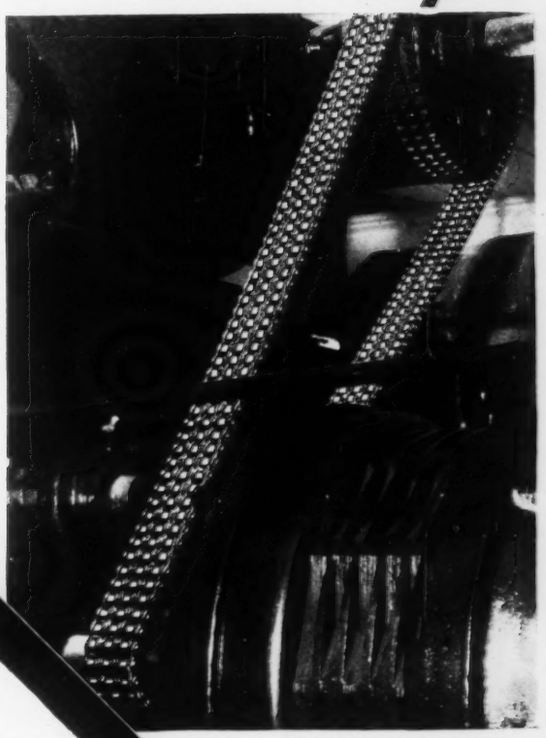
Controller is designed for equipment where starting load is unusually severe

Use Them Both Ways

1. On Your Motor Drives



Diamond Roller Chain on fig grinder. Slow speed and heavy peak loads. Gears were short-lived and noisy. Chain is accessible, simple to install.



Diamond Roller Chain replaced another make of chain on the oven conveyor drive—has already lasted twice as long.

2. On Machines You Build

IN plant operation—in design (if your product is a machine) Diamond Roller Chain is an almost universal answer to your drive problems.

Diamond Drives incorporate the roller-bearing principle—maintain over 98% efficiency. They are positive—no slippage,—no variation in speed-ratios. Initial and maintenance costs are low.

On machines you build, Diamond Chain is a tremendous help in design because of flexibility of application. They run over sprockets or under them in either direction, between long centers or short. They can be installed or removed in a few minutes without dismantling the machine.

The coupon below names two interesting booklets—either one or both will be sent on request . . . without obligation.

DIAMOND CHAIN & MFG. CO.
435 Kentucky Ave., Indianapolis, Indiana
Offices and Distributors in Principal Cities

DIAMOND ◇ DRIVES

for Every Industrial Need

This Diamond on every link identifies the Diamond Drive

Quiet — Clean — More Compact per H. P. Transmitted

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue, Indianapolis, Indiana

Gentlemen: Please send me a copy of Booklet 102-B, *"Reducing the Cost of Power Transmission,"* and of Booklet 104-A *"Simplifying and Improving Machine Design."*

*Name*_____

*Firm*_____

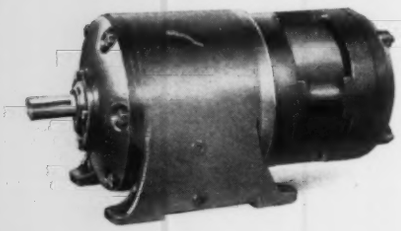
*Address*_____

*City*_____ *State*_____

load protection for the motor is furnished if desired. The starter, which is designed for direct current use, is mounted in a dust tight split enclosing case.

Geared Motors Are Available

FOR use where low-speed drives are required, Allis-Chalmers Mfg. Co., Milwaukee, has developed a motor reduction unit which consists of a standard round frame type motor mounted directly on the gear reducer housing. Thus a compact unit is formed. Helical gears are used, permitting high efficiency and quiet operation. Standard speeds at the power take-off are from 3.02 to 380 revolutions per minute, but lower speeds can be provided; 6.08 revolutions per minute is obtained with the use of a 1750 revolutions per minute motor.



Many types of motor can be employed with new line of motorized speed reducers

The bearings supporting the gear drives are ball or roller type. Lubrication is automatic and continuous, insuring an adequate supply of lubricant at all times. Standard units are arranged for floor mounting, while units can be supplied for wall, ceiling or vertical mounting. Any type of motor may be supplied including standard squirrel cage induction, wound rotor, enclosed fan cooled, explosion proof or direct current.

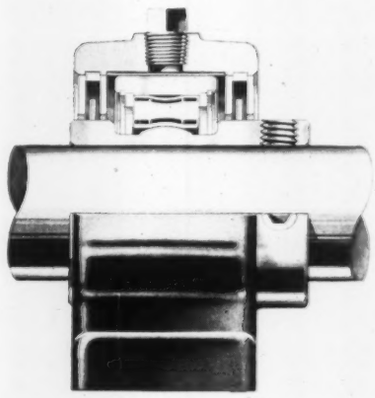
Nickel-Clad Steel Finish Improved

A NEW finish has been developed for nickel-clad steel, a hot rolled bimetal made up of a light layer of pure, solid nickel bonded to a heavy layer of flange quality steel, by International Nickel Co., and Lukens Steel Co., Coatesville, Pa. With this finish, classified as hot rolled and cleaned, the steel is free from the brown nickel oxide on the nickel side. This oxide is formed during the rolling of the bimetal at high temperatures and is somewhat similar to the finish on standard hot rolled steel plates.

While the oxide type of finish will continue to be produced, due to the corrosion resistant properties of the nickel oxide, the new finish has been planned for the many uses where a cleaner appearance will be beneficial. The cleaning process gives the nickel a matt appearance nearly white in color. This hot rolled and cleaned finish, however, should not be confused with the bright, lustrous surface of cold rolled and full finished solid nickel sheet, where refinement is obtained by cold rolling. Nickel-clad steel now is available in rectangular plates and circles in a wider range of sizes than heretofore.

Roller Bearings Are Self-Aligning

A NEW line of single row, self-aligning roller bearings is being offered by Shafer Bearing Corp., 621 South Kolmar avenue, Chicago. A single row concave bearing is used with roller operating between a straight outer race and a convex inner race. This design assures sufficient radial load capacity with provision for the limited thrust capacity needed in applications having moderate loads.



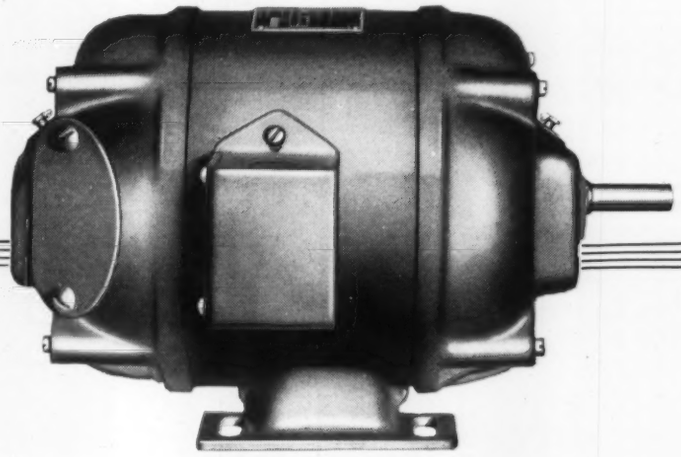
Self-aligning bearing compensates for misalignment due to inaccuracies in machining or shaft deflection under load

Self-alignment is obtained in the bearing itself, thus compensating for misalignment due to inaccuracies in machining or shaft deflection under load. The bearing is of the full roller type, a retainer being omitted. Thrust is taken by means of hardened and ground thrust plates. In addition to the pillow block, shown herewith, the light duty bearings are available in flange units, hanger boxes and take-up units for shafts from 9/16 to 2-3/16 inches inclusive.

Announces Improved Contactors

SOLENOID operated contactors in a new line for alternating current applications requiring a remote control switch have been announced by Allen-Bradley Co., 1311 South First street, Milwaukee. The contactors, shown herewith, are made in single or multiple pole con-

"THEY KEEP A-RUNNING"



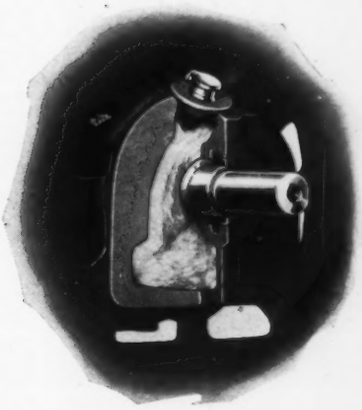
1/6 Horse Power Century Type RS
Repulsion Start Induction Single Phase
60 Cycle 1750 R. P. M. Motor

Continuously Dependable LUBRICATION

ONE of the greatest assets a manufacturer can build into his motorized product is the assurance of continuously dependable motor lubrication provided by the Century Wool Yarn System of Lubrication. Beginning March, 1924, this system has been standard on 1 horse power and smaller size Century Motors. Since that time its positive ability to keep a motor properly lubricated for at least 1 year's continuous 24-hour-per-day operation—without reoiling—has been amply demonstrated in many hundreds of thousands of installations in all parts of the world.

The Sleeve Bearings in these motors are machined from Phosphor Bronze Castings—tough, close grained, they will outlast most driven equipment.

CENTURY ELECTRIC COMPANY
1806 Pine Street · · St. Louis, Mo.
Offices and Stock Points in Principal Cities



The Century Wool Yarn System of Lubrication consists of continuous, unbroken strands of pure wool yarn and assures a constant delivery of filtered oil to the bearing surfaces.

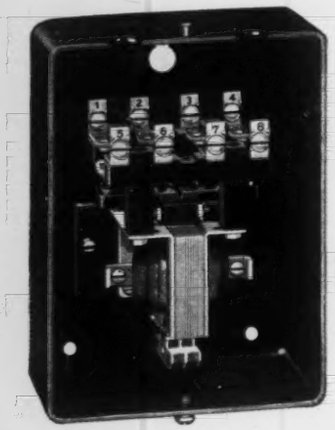
Century
MOTORS

RS-124-1/6

FOR MORE THAN 28 YEARS AT ST. LOUIS

struction with silver-to-silver contacts up to and including an 8-pole unit for two-wire control.

Contacts are supported on self-contained insulating cross pieces and require no slate panels,

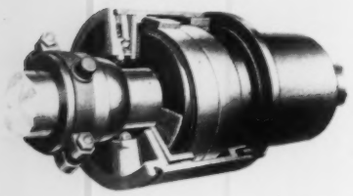


Contactors are made in single or multiple pole construction with silver-to-silver contacts

so they can be mounted directly on metal panels or machines. The operating coils can be furnished for any frequency in voltage—6, 12, 24, 110 and 220 being standard.

Cut-off Coupling Is Disk Actuated

DRIVING and driven sections of the new spiral friction cut-off coupling introduced by Kinney Mfg. Co., 3541 Washington street, Boston, are held in line by a ball guide bearing. The driving mechanism in the unit, shown herewith, consists of a spiral band contracting on to a driv-



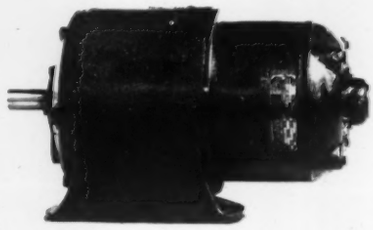
Cut-off coupling can be furnished for either dry or lubricated friction surfaces

ing hub, the band being actuated by a flat friction disk faced with asbestos. Power is transmitted by the spiral band. The sole duty of the friction disk is to contract the spiral. Shifter sleeve is of the cone type, while all parts of the shifter mechanism which are subject to wear are heat treated, hardened steel.

Reducer Uses Any Type of Motor

MOTORIZED speed reducers which may employ nearly any type of motor have been placed on the market by Louis Allis Co., Milwaukee. The motor and speed reducer are combined into a self-contained unit which may be mounted easily on the machine. Ratings available are ¾ to 75 horsepower with output speeds of 4 to 400 revolutions per minute.

These units can be furnished with motor characteristics and style of mounting best suited to each application. The integral style, shown herewith, in which the end bell is removed and the motor close-coupled to the gear casing, is most common where an open motor or an enclosed nonventilated motor is employed. The flexible style, in which the entire motor without any change is mounted on the gear casing,



Automatic and continuous lubrication is supplied on motor reduction unit

is furnished where conditions require an explosion proof, splash proof or other protected type of motor. Either style can be furnished to provide normal starting torque, high starting torque, high slip, adjustable speed, multispeed or other desirable characteristics that can be built into separate motors.

Magnetic Clutch Is Extremely Small

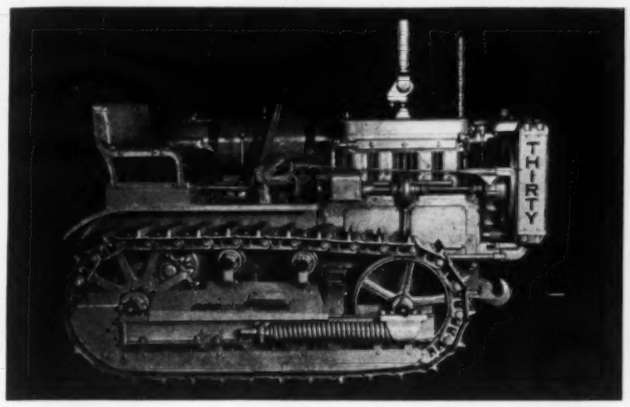
HIGH torque with compact construction is available with the magnetic clutch built by Magnetic Mfg. Co., Milwaukee, which is only 5

Small magnetic clutch embodies few parts, yet has unimpaired efficiency

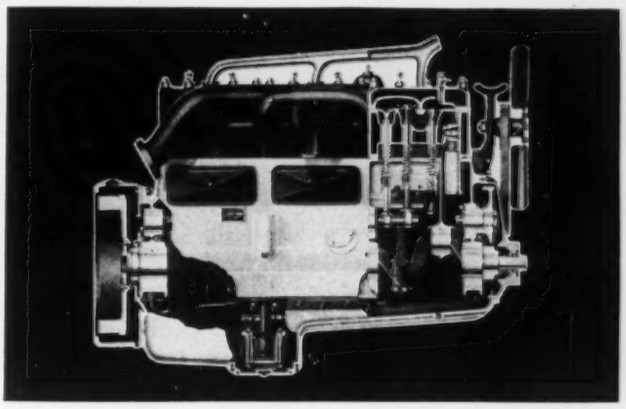
inches diameter, yet develops 500 pounds inches pull-out torque. The clutch, shown herewith, is simple in design and embodies few parts. Electrical and mechanical efficiency are not impaired by its simple construction. Collector rings are located on the outside diameter, staying well within the diameter of the clutch. The

WHAT'S YOUR JOB?

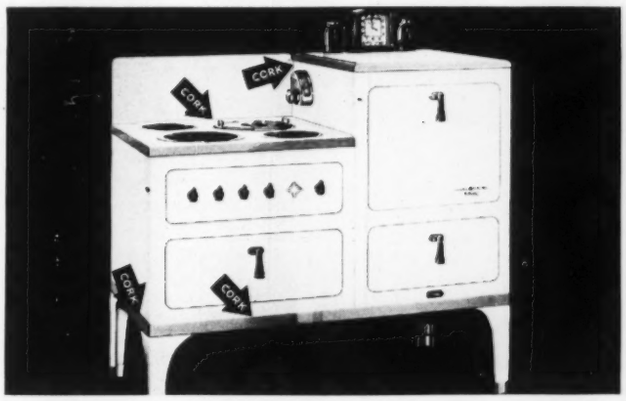
WE ALTER THE CHARACTERISTICS OF CORK TO FIT YOUR NEEDS



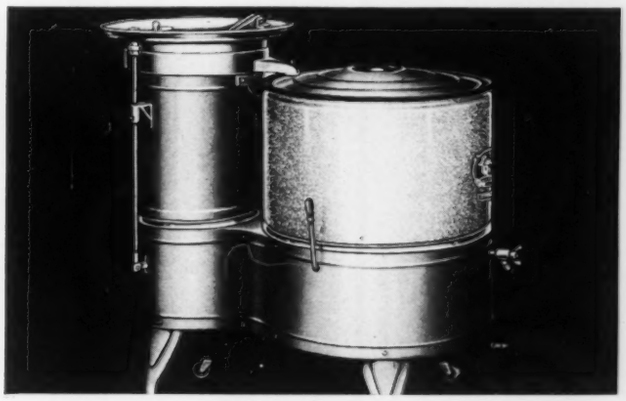
OIL SEALS . . . Caterpillar's problem was to keep water, sand, dust from the track rollers and to keep in the oil. In field and forest, swamp and desert those bearings have to be protected against grit and lubricated without leakage. Armstrong's Cork was chosen because of its unique combination of properties. Resilience, compressibility, and resistance to liquid penetration are *controlled* according to the needs of the service.



GASKETS . . . No oil can ooze through! The Waukesha Engine, designed for heavy duty truck and bus work, is sealed at vital points with Armstrong's Cork. In this sort of combustion engine, gaskets must be leakproof, and must fit accurately. Armstrong's Cork fills both requirements . . . which accounts for the widespread use of these gaskets by the Waukesha Motor Company and other manufacturers of engines and automobiles.



CUSHIONING . . . How to bolt porcelain to porcelain without chipping? That question is answered by strips of Armstrong's Cork in the General Electric Hotpoint Range. They cushion the joints and prevent chipping or cracking when bolts are drawn tight for a rigid assembly. Armstrong's Cork *keeps on cushioning*, won't lose its resilience.



FRICTION DRIVE and BRAKE . . . After testing various materials, Grinnel Washing Machine engineers selected Armstrong's Cork as the most efficient material for transmitting power and for braking. A cork friction disc drives a cast iron wheel. A cork brake disc stops the machine. Armstrong has special compositions for such services.

HOW ABOUT YOUR PROBLEM!

Our Industrial Sales Engineers can help you with your problems of driving, braking, cushioning, sound deadening, insulation, or sealing. Armstrong's Cork can be shaped and controlled to your specifications. Outline your problems and send a blueprint, if possible. Armstrong Cork & Insulation Company, Industrial Sales Division, 918 Arch Street, Lancaster, Pennsylvania.

Armstrong's (A) *Product*

Armstrong's
CORK
MADE TO YOUR SPECIFICATIONS

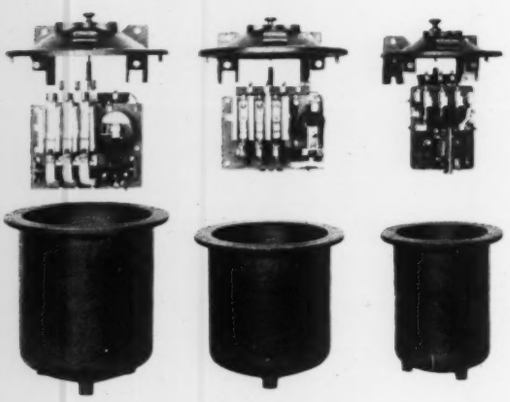
unit is a true single disk clutch in that it has only one friction or wearing surface. Current consumption is approximately 100 watts. Length is 3¾ inches.

Magnetic Switches Are Protected

A LINE of full voltage magnetic switches built to the standards of the Underwriters' laboratories for industrial control equipment for use in Class I, Group D hazardous locations has been announced by General Electric Co., Schenectady, N. Y. These switches, shown herewith, are weatherproof as well as being suitable for use in corrosive atmospheres.

The devices consist of standard magnetic switches with special operating coils and contact tips for operation under oil, and an oil immersed temperature overload relay. The enclosure is explosion proof having been designed to meet Underwriters' requirements for air-break switches, and the oil is used only to protect the magnetic switch and the overload relay against corrosive fumes.

For use in connection with these switches, a



Magnetic switches have been approved for use in hazardous locations

push button station also meeting specifications has been developed for remote control in hazardous locations. This new line of devices supplements the similar line of explosion proof switches which have air-break contacts.

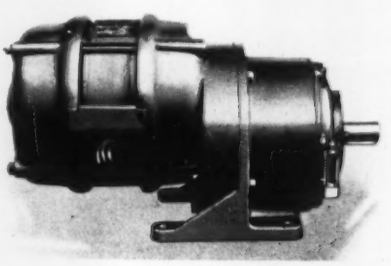
Coupling Provides Infinite Speeds

APPLICABLE for installations such as pumps and fans, the hydraulic coupling being marketed by American Blower Corp., Detroit, gives an infinite number of driven shaft speeds ranging down to about 20 per cent of the motor speed. The unit allows the motor to be started under practically no load conditions.

Power is transmitted by the kinetic energy of a liquid discharged by the impeller directly against the vanes of the runner. A continuous circulation of oil takes place from the coupling through the scoop tube to the gravity tank and back to the coupling. There are no packed joints or high pressure fittings on the unit.

Develops Motor Reduction Unit

NO MOTOR coupling is used on the gear reduction units built by Ideal Electric & Mfg. Co., Mansfield, O., as the high speed gear is mounted directly upon the motor shaft. These units, shown herewith, are available in all gear ratios from 2.09:1 up to 376:1, giving output speeds of from 4.7 to 861 revolutions per minute using the standard 1800 revolutions per minute motor.



Two, three or four-speed motors can be supplied for use with line of geared motors

For reduction ratios up to about 6 to 1, the reducer consists of a single stage helical gear unit. For higher ratios up to and including 24.5 to 1, a two-stage helical gear reducer is used. For reduction ratios of 30 to 1 and higher one stage of helical and one stage of heliocentric gears gives the required reduction. The units employing heliocentric gears have the motor hung on the reducers, while other units have the reducer hung on the motor.

Geared motors are supplied in all horsepowers from ¾ to 20. Either open or enclosed type motors are furnished, for 2 or 3-phase alternating current or for direct current. Two, three the reducer hung on the motor.

Bonds Stainless and Carbon Steels

STAINLESS steel and plain carbon steel are combined in the ingot and rolled together to form the new product of Allegheny Steel Co., Brackenridge, Pa. The resulting material is a solid sheet of plate, 20 per cent of the thickness of which is 18-8 chrome nickel steel and the remainder mild steel. An advantage of the com-

Patronize Your *Udylite* Jobber - -

This is the sign which stands for quality rust protection and quality service. It assures you that your corrosion problems will be given the prompt and efficient attention of rust proofing specialists.

From New England to the Pacific Coast, you see this sign—the identification of the authorized Udylite jobber. There are approximately one hundred of these authorized jobbers located in all principal industrial centers. They serve the needs of thousands of plants manufacturing metal products.

Be sure of satisfaction and refer your rust proofing requirements to an authorized Udylite jobber who has a reputation for honesty, trustworthiness and efficiency to sustain. A glance at the list of jobbers will give you the name of the one nearest you. Call him and obtain Udylite-Cadmium—the finish that not only protects but also beautifies.

UDYLITE PROCESS COMPANY

3937 Bellevue Avenue Detroit, Michigan

New York City	Chicago	San Francisco
30 East 42nd Street	205 Wacker Drive	1114 Sansome Street

AUTHORIZED *Udylite* JOBBERS

Calif.,	*Glendale,* Industrial Plating Co.
	Los Angeles, Cadmium & Nickel Plating Co.
	Franz Mch. Tool & Die Wks.
	Pacific Enameling & Pl't'g Co.
	Western Galvanizing Co.
	Oakland, Progressive Pl't'g & Enameling Wks.
	Pasadena, Crown City Plating Wks.
	San Diego, Universal Plating Wks.
	San Francisco, Golden West Plating Wks.
Colo.,	*Denver,* Sachs Lawlor Co.
	Pueblo, Rocky Mountain Pl't'g Wks.
Conn.,	*Hartford,* Nat'l Sherardizing & Mch. Co.
	Plainville, Plainville Electro Plating Co.
Ill.,	*Aurora,* Aurora Plating Co.
	Batavia, Challenge Co.
	Chicago, Electro Galvanizing Co.
	Great Lakes Plating Co.
	Vacuum Can Co.
	Western Rustproof Co.
	Peoria, Central Plating & Fixture Co.
	Quincy, Quincy Enameling & Pl't'g Co.
Ind.,	*Elkhart,* Chicago Telephone Supply Co.
	Ideal Plating Co.
	Evansville, Millers Plating Wks.
	Fort Wayne, Wayne Metal Protection Co.
	Goshen, Standard Plating Wks.
	Kokomo, Midwest Rustproofing Co.
	Muncie, Kiser Plating Co.
	Richmond, Lahman Plating Wks.
	South Bend, Swanson Plating Wks.
Iowa,	*Davenport,* Iowa Silver Plating Wks.
	Waterloo, Chamberlain Corp.
Ky.,	*Louisville,* Kentucky Plating Co., Inc.
	Reliance Plating Wks.
Md.,	*Baltimore,* D. R. Holmes
	Frederick, Everedy Co.
	Middle River, Glen L. Martin Co.
Mass.,	*Boston,* Rust Proofing & Metal Fin. Corp.
	Springfield, T. J. Murray
Mich.,	*Ann Arbor,* Barnard & Hammond
	Bay City, Leo D. Goddeyne
	Detroit, Detroit Plating Industries
	Parker Rust Proof Co.
	White Rust Proof Co.
	Flint, Standard Electroplating Co.
	Grand Rapids, Grand Rapids Plating Co.
	Valley City Plating Co.
	Jackson, Chromium Plating Corp.
Minn.,	*Minneapolis,* Superior Pl't'g & Rustpr'fing Co.
	St. Paul, Minnesota Plating Wks.
Mo.,	*Kansas City,* Bar-Rusto Corp.
	St. Louis, St. Louis Rustproofing Co.
N. H.,	*Nashua,* Nashua Brass Co.
N. J.,	*Newark,* Pyrene Mfg. Co.
N. Y.,	*Buffalo,* Keystone Chromium Corp.
	Marlette Plating Co.
	Union Polishing & Pl't'g Co.
	No. Syracuse, Salina Plating Wks.
Ohio,	*Akron,* Nat'l Sherardizing & Mch. Co.
	Alliance, Alliance Mfg. Co.
	Bryan, Ohio Plating Co.
	Bucyrus, Bucyrus Plating Wks.
	Cincinnati, Stolle Corp.
	Cleveland, Wagner Rustproofing Co.
	Columbus, Columbus Metal Prod., Inc.
	Dayton, St. Clair Plating Co.
	Massillon, Massillon Pl't'g & Rustproofing Co.
	Minerva, Liberty Bell Mfg. Co.
	Toledo, Gerity Whitaker Co.
	Jas. E. Nagle & Son, Inc.
	Wm. Whitaker & Son
	Warren, Wetzel Plating Co.
	Wellington, Cleveland Steel Products Co.
Okla.,	*Tulsa,* Tulsa Plating Wks.
Ore.,	*Portland,* California Plating Wks.
Penna.,	*Erie,* Erie Plating Wks.
	Lancaster, K D Mfg. Co.
	Philadelphia, Philadelphia Rust Proof Co.
	Pittsburgh, Walter E. Hague & Son, Inc.
	Wilkes-Barre, Johnson Eng. & Mfg. Co.
R. I.,	*Providence,* General Fittings Co.
Texas,	*Cuero,* H. G. Keseling Sheet Metal Wks.
	Dallas, Dallas Mfg. & Plating Co.
	Dallas Silversmithing Co.
	Fort Worth, Axtel Co.
	Houston, Dixie Electro Plating Co.
	San Antonio, Southern Plating Co.
Va.,	*Norfolk,* Whaley Aircraft & Eng. Co.
Wash.,	*Seattle,* Eagle Plating Wks.
	P-G Emblem Co.
	Whitehouse Plating Co.
Wisc.,	*Beloit,* Rock County Buick Co.
	Madison, Capitol Plating Machine Co.
	Milwaukee, S. K. Williams Co.
	Racine, Shephard Plating Co.

(CADMIUM) *Udylite*

bination sheet is its comparative ease of fabrication, as the physical characteristics of the sheet approach more nearly those of the mild steel which makes up 80 per cent of its thickness.

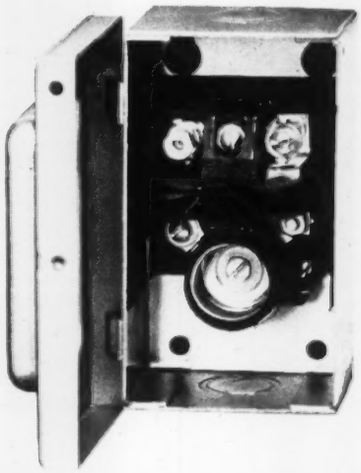
The metal clad plate, licensed under Ingersoll patent No. 1,868,749, is said to have an indissoluble bond between the two metals. It can be applied wherever a corrosion resisting surface is required, or where the appearance of the stainless steel is desired.

Front-Operated Switch Is Compact

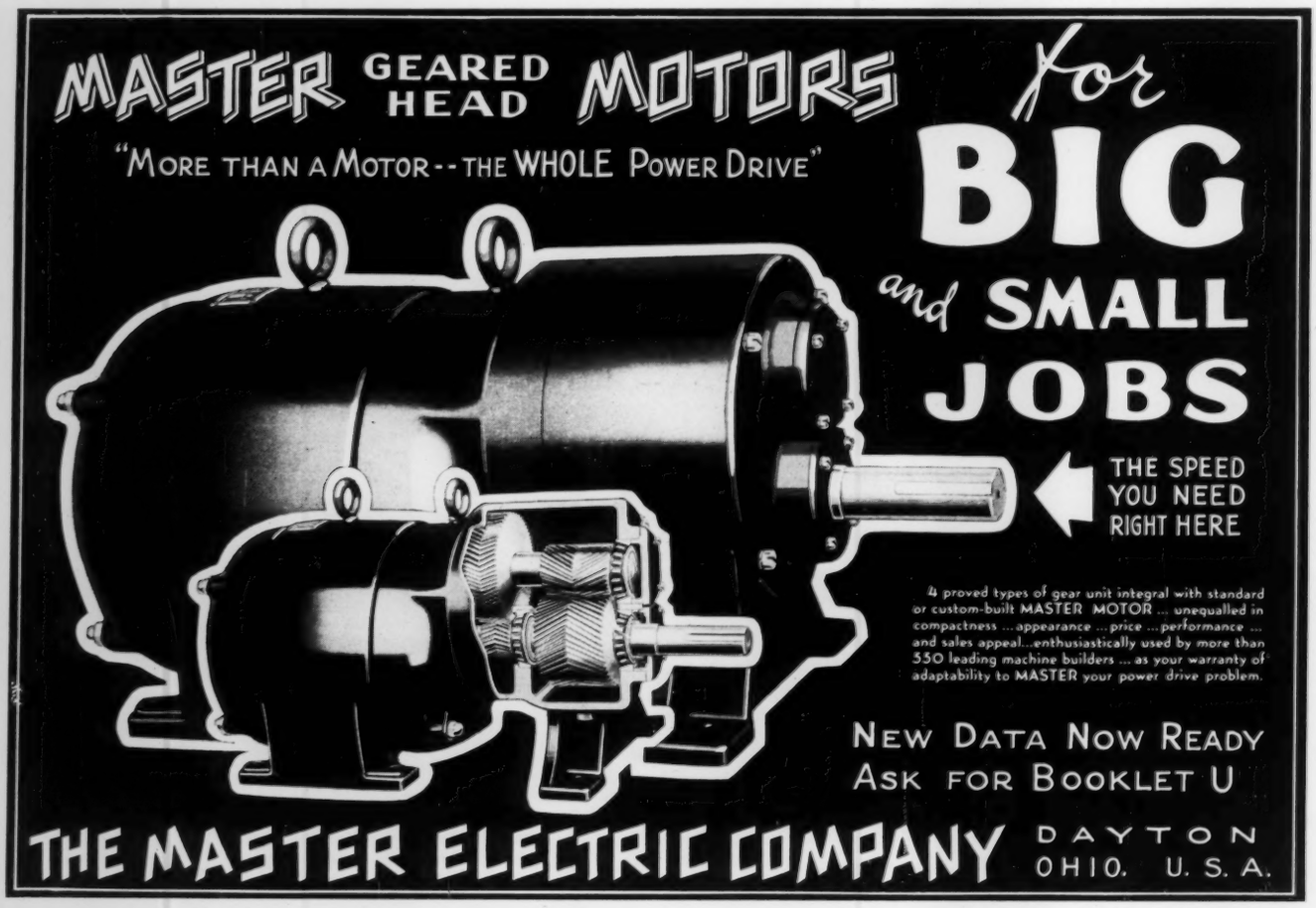
ESPECIALLY designed for resale machinery manufacturers, the compact, front-operated switch introduced by Switch and Panel divisicn, Square D Co., Detroit, is only 5 3/8 inches high by 3 1/8 inches wide and 2 3/4 inches deep yet it has a capacity of 30 amperes or 1 horsepower at 125 volts. The unit, known as Catalog No. 90211, is a two-pole switch with one fuse, one blade and solid neutral.

Front operation of the switch, shown herewith, is obtained by the special design; the switch is one of the conventional knife blade construction, but embodies a small disk rotating between two spring copper blades. This feature permits a small sized cabinet and convenient operation without the necessity of providing for blade swing or a side operating handle.

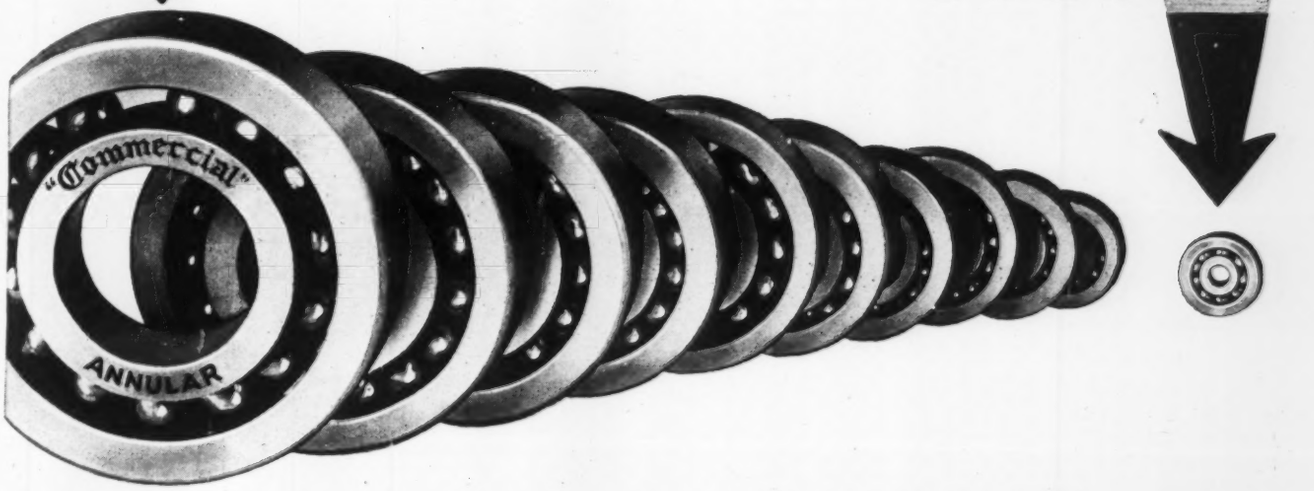
Considerable attention has been given to the appearance of the switch. Standard finishes are bronze or black, but other colors may be had to match the machinery or equipment upon which it is to be mounted.



Compact, front-operated switch is designed especially for resale machinery manufacturers


MASTER GEARED HEAD MOTORS
"MORE THAN A MOTOR -- THE WHOLE POWER DRIVE"
for BIG and SMALL JOBS
THE SPEED YOU NEED RIGHT HERE
4 proved types of gear unit integral with standard or custom-built MASTER MOTOR ... unequalled in compactness ... appearance ... price ... performance ... and sales appeal...enthusiastically used by more than 550 leading machine builders ... as your warranty of adaptability to MASTER your power drive problem.
NEW DATA NOW READY
ASK FOR BOOKLET U
THE MASTER ELECTRIC COMPANY
DAYTON OHIO. U. S. A.

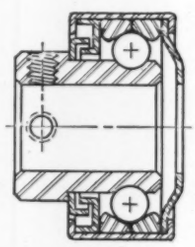
From THIS to THIS



AND ALL SIZES IN BETWEEN

WE MAKE bearings for every industry and every purpose. We can provide you with stock bearings, or bearings made to your own B.P. specifications. Bearings of various sizes for every type of installation. In other words, The Schatz Manufacturing Co. may be considered as "bearing headquarters".

Our Engineers are glad to assist in suggesting methods for improving installations. Long experience enables us to solve the most difficult installation problems.



"COMMERCIAL" Annular Ball Bearings have a larger number of balls which means additional wear and strength. Speeds up to 2500 R.P.M. Dual thrust capacity and most important of all—moderate cost for quality performance.

Write for Information, Price Lists and Samples

THE SCHATZ MANUFACTURING CO.
Poughkeepsie, New York
Detroit Sales Office: 2608 Book Tower; Chicago Sales Office: 120 N. Peoria St.

"Commercial" BEARINGS

ALLEN

TRI-MARKT

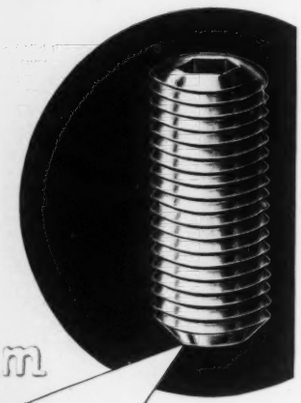
TRADE MARK

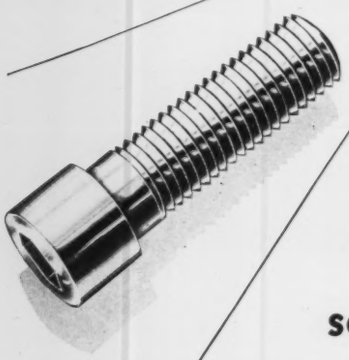
HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um





What you *must* ask of hollow screws is that

they hold

— then ask the price

HOLDING-POWER demands the exceptional in socket-wall strength, in precision of wrench-fit; accuracy of threading, flawless finish. It demands what only the ALLEN has. The necessity of making hollow screws HOLD is the reason Allen holds to its quality and to prices permitting that quality to be maintained. Ask for *free test samples* to try in your present machines or for new designs. » »

THE ALLEN MFG. COMPANY

HARTFORD, CONN. U. S. A.

Supplementing Efficiency with Good Looks

(*Concluded from Page* 25)

which the checks are withdrawn, and the single word "Checks" was debossed across the front of the casting, with the letters lacquered in vermillion to give them attention value. The main body of the case was finished in a crinkled lacquer of French gray, although this method allows a choice of color in order to meet the requirements of individual purchasers.

We thus have a simple and logical housing costing no more to produce than the old one and having in addition, a number of decided practical advantages. The form is simple but striking, and its scheme of French gray with notes of chrome plate and black at top and bottom and a single, striking note of vermillion, is individual but not garish. It has met with immediate success.

Strict Co-operation Essential

In both these instances—as in many others that might be cited, from thermometers to 16-cylinder motor cars—the results have been achieved by working closely with the engineers responsible for the development and manufacture of the machines. In almost every instance the work of the industrial designer consists in outlining to these technical men the object to be achieved and relying upon them to discover a means for arriving at that end. New requirements in design often raise serious problems. Sometimes these cannot be surmounted and it is necessary to revise the design in a more practical but equally attractive manner. Very often the difficulties can be overcome. In any case, mutual confidence and co-operation are essential. The designer and the engineers must be able to sit down together and iron out their problems as they arise, and they must sit by the bedside of the new-born infant and watch over it with ceaseless vigilance until it is ready to go out into the world.

In this way of working there is no excuse for an industrial designer remaining merely a meddlesome outsider who makes life more difficult for the already overworked engineering staff. If he has a wholesome respect for their knowledge and their difficulties and they have a reasonable amount of confidence in his practical common sense as well as his designing ability, they can work together in complete accord and with highly satisfactory results to the great benefit of the products for which they share a responsibility.

Quality

IN THE PRICE CLASS

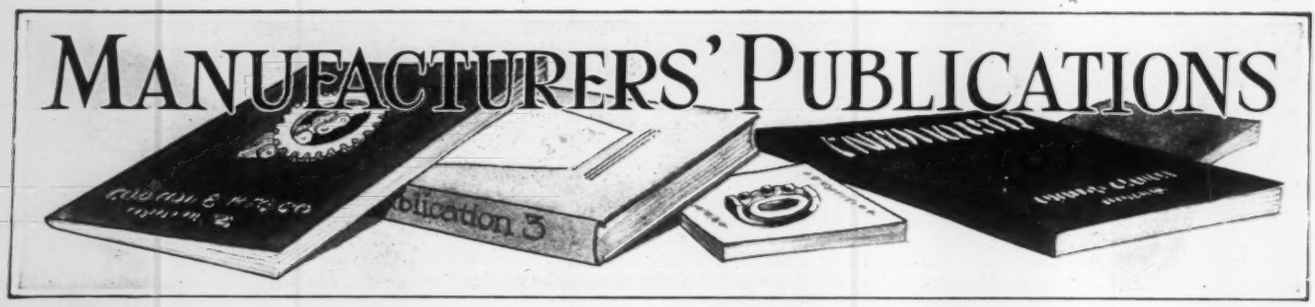
The demand today is not for price or quality alone *but for quality at a price* ... The model E E and E E X motors illustrated meet this exacting requirement .... These motors are built to the well-known Dumore quality standards. They develop 1/75th H. P. and are of the universal type with balanced armatures. They are enclosed in a tightly-fitting die cast housing and are equipped with self aligning bearings in addition to possessing other typical Dumore quality features ... Investigate the application possibilities of these two models! .... Send us a print of your requirements. The Dumore engineering staff may be of assistance to you in the application of either of these two Dumore models to your product.

DUMORE COMPANY
100 16th Street Racine, Wis.

Send for bulletins which fully describe the Dumore Double Gear Reduction Units. These bulletins contain complete technical data regarding reductions, shaft speeds, dimensions and etc.

DUMORE
FRACTIONAL HORSEPOWER
MOTORS

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

ALLOYS (STEEL)—Stainless steels and their uses are covered in a new 20-page bulletin of Electro Metallurgical Co., New York. The booklet describes the advantages of the material and its applications, and presents photographs showing its use in many industries.

BEARINGS—Catalog No. 12 of Shafer Bearing Corp., Chicago, presents complete information on the entire line of self-aligning units manufactured by the company, including the new line of single row bearings recently announced. The catalog gives sizes, dimensions, load ratings and similar data.

CONTROLS (ELECTRICAL)—Square D Co., Detroit, has issued a bulletin on its Catalog No. 90211 switch, a small, compact, front-operated switch for resale machinery manufacturers.

DRIVES—B. F. Goodrich Co., Akron, O., has published a 4-page booklet on its Highflex belting entitled "Lubricated with Rubber." The booklet points out how the rubber on the belt acts as a lubricant, its elasticity allowing the belt plies to slide over each other.

DRIVES—Link-Belt Co., Chicago, is issuing catalog No. 1457 on its new Silverlink roller chain which has side bars especially treated to assist in resisting corrosion. This treatment gives the side bars the appearance of silver. The chain is available in all sizes from ⅜ to 2½-inch pitch.

DRIVES—Philadelphia Gear Works, Philadelphia, has prepared a new catalog on its line of MotoReduceRs in the horizontal and vertical types. The catalog describes the equipment, gives dimensions, complete tables of horsepower ratings and speed reductions from ½ to 75 horsepower, and a table and formulas for maximum overhung load.

DRIVES—Universal Gear Corp., Indianapolis, has prepared a 16-page bulletin on its line of motorized reducers which are available in horizontal or vertical types and fractional and integral horsepowers. The bulletin describes the line, supplied in all ratios, gives features of design, dimensions and engineering information. Heliocentric reducer elements are used in ratios above 25:1.

MATERIALS (COMPOSITION)—Dilecto, a laminated synthetic material manufactured by Continental-Diamond Fibre Co., Newark, Del., is presented in a 40-page booklet recently issued by the company. Besides a general description, applications, specifications and similar information, the booklet includes a table of standard grades and sizes of the material and their properties. Another table gives a comparison of the properties of hard rubber, vulcanized fiber and synthetic phenol resins.

MOTORS—A complete line of motors of from 1/10 to 10 horsepower manufactured by the Brown-Brockmeyer Co. Inc., Dayton, O., is presented in two new bulletins of the company. Points in design and manufacture are described in detail, while tables give electrical data, horsepowers, and similar information on each of the types manufactured.

PUMPS—A new design of rotary displacement pumps for oil service is described in a bulletin of De Laval Steam Turbine Co., Trenton, N. J. These pumps require no valves, no pilot gears and no separate bearings. There are only three moving parts.

PACKING GLANDS AND PACKING—A comprehensive handbook on industrial packing materials has been issued by Felt Products Mfg. Co., Chicago, This handbook not only contains descriptions and lists of uses for which each material is suited, but also includes samples of 36 different materials. In addition to felt, the materials employed alone and in combinations include asbestos, cork, aluminum, rubber, cloth, paper and leather.

WELDED PARTS AND EQUIPMENT—Linde Air Products Co., New York, is distributing a 20-page booklet on Oxweld No. 25M bronze welding rod. The booklet describes the physical and welding characteristics of the rod.

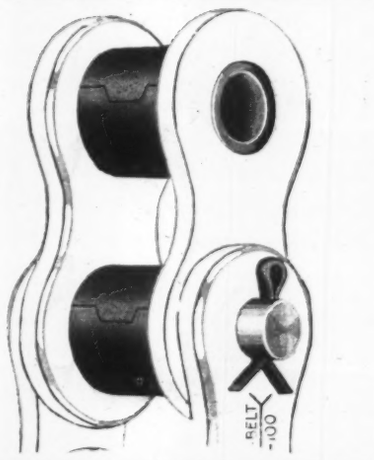
Research Publications

International Comparison of Electrical Standards, by George W. Vinal. This paper gives in detail the results of comparisons made by the national laboratories of Germany, England and the United States and shows that there are differences in the values of standard cells and resistances which are large enough to suggest the necessity for a readjustment of the units as maintained by the laboratories. Silver voltameter measurements were in good accord. Available through Superintendent of Documents, Government Printing office, Washington. 21 pp. 5 cents.

Effect of Casting Temperatures and of Additions of Iron on Bearing Bronze, by C. E. Eggenschwiler. A study made of the effect of different casting temperatures and of additions of iron upon the hardness, the structure and the resistance to wear, to pounding and to single blow impact of bearing bronze containing 80 per cent copper, 10 per cent tin and 10 per cent lead. Published by bureau of standards. Available through Superintendent of Documents, Government Printing office, Washington. 9 pp. 10 cents.

LINK-BELT
SILVERLINK
ROLLER CHAINS

IN presenting Link-Belt Silverlink Roller Chain, we are offering a product that represents the highest point of accomplishment in roller chain development. We have constantly improved our product since the inception of the Link-Belt organization back in 1875—57 years



ago—and it is due to our unending research work that we have maintained our position as the leader in the art of chain manufacture.

Built to the Highest Standards

All the qualities that have heretofore made Link-Belt Roller Chain so dependable have been retained in the Silverlink Chain. From raw material to finished product, tested and ready for service, every step in the chain manufacturing process is in our control.

The raw material is made to our exacting specifications. It is then carefully analyzed in our own laboratory. Each step in the manufacture of the chain thereafter is measured to the most exacting standards. The closest tolerances are maintained to secure uniformity and accuracy of pitch throughout the chain, so essential to long life and smooth operation in service.

Our unequalled heat treating facilities assure strength and toughness to the alloy rolled steel side bars and rollers, and correct case-hardening of the nickel steel pins, and the bushings. Every foot of Link-Belt Chain is tested under load for physical strength and wear value.

The sidebars of all Link-Belt Silverlink Roller Chains are especially treated to assist in resisting corrosion. Their silver color symbolizes the quality we have built into them.

Extensive Stock Service

Never before have we offered such a variety of chains, wheels and attachments, to suit practically every condition of service. With the large stocks carried in Link-Belt warehouses, and by distributors throughout the country, Link-Belt quality is instantly available to Roller Chain users.

In addition, we now have a much broader range of wheels available from standard patterns located at our several plants.

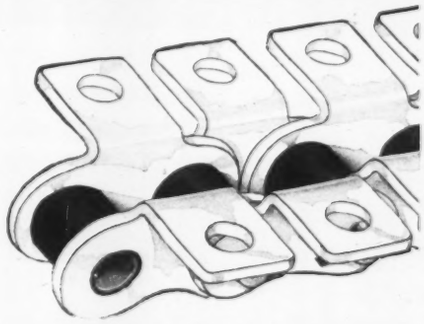
Roller Chains Constantly Improved

Roller Chains are not new. But their performance, efficiency, and long life have been bettered by improved materials, improved machinery for making the parts within the close limits demanded, improved technic and more accurate control of the heat-treatment, wider knowledge of chain action, and a better comprehension of proper sprocket wheel design. Roller Chain is in wide use today because designers and engineers recognize its distinct field of utility.

There is a correct use for each type of chain in industrial power transmission and conveying. Link-Belt makes every type of driving and conveying chain, and is, therefore, in a position to make unbiased recommendations as to the best type of chain for the particular conditions encountered. There is no one chain that is suited for all operating requirements.

Roller Chain for Power Transmission

Roller Chains should be used within their proper range of application, so as to give the maximum service per dollar invested. They



carry heavy loads at moderate chain speeds, with high efficiency, and are extremely durable and satisfactory in second-reduction drives and similar applications. They are particularly adaptable for intermediate, built-in drives, and for the coordination of the motion of widely separated shafts within a machine.

Roller Chain as a Conveying Medium

The use of Roller Chain as a conveying medium is rapidly increasing. It is exceptionally well suited for built-in systems in automatic machinery, and where accurate timing is desirable. By the use of attachment links, it is possible to fasten a wide variety of carrier members to the chain.

Next in efficiency and speed range to Link-Belt Silent Chain, Silverlink Roller Chain occupies an important place in the Link-Belt family of power transmission equipment. On high-speed drives where extreme smoothness of transmission is called for, the Link-Belt Silent Chain Drive is the better selection. It will last longer and run more quietly.

Study Each Application

Link-Belt Roller Chains furnish the sinews of power within the machine. They rarely serve as the connecting link between the driving motor and the machine. There are, however, places where Roller Chain can be used as a direct motor drive. Each application deserves a careful study of individual conditions, and of the qualifications of all of the various forms of power transmission available for the purpose. Where the input power must be supplied at a low r.p.m. compared with the speed of the driving motor, Link-Belt unit speed reducers, available in various types in speed ratios up to 1,000 to 1, may be the better choice; or, in reductions up to 20 to 1, the Silent Chain Drive will be found entirely practicable, and capable of rendering years of efficient service.

Roller Chain Is Reversible

Because Roller Chain is reversible and can be run on either side, it can be wound back and forth over a series of sprockets, where alternate directions of rotation are sought. The inherent flexibility of Roller Chains well suits them for various types of road building equipment, agricultural machinery, trucks, and other apparatus used over irregular terrain. The use of Roller Chains on trucks and tractors has proved their satisfactory performance in this trying service.

Made to Manufacturers' Standards

Roller Chains and wheels are made to Manufacturers' Standards approved by the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the American Gear Manufacturers' Association. This assures interchangeability.

The Link-Belt wheel tooth form is designed to compensate for increase in pitch due to natural chain wear. Should wear become serious, this form of drive is easily serviced.

Link-Belt Service

Back of Link-Belt Silverlink Roller Chain stands the reputation of a company that has been serving the power transmission and materials handling equipment fields continuously for over 50 years. Accumulated in its files and engineering organization is a vast experience extending into all phases of industrial activity. This experience is at your service.

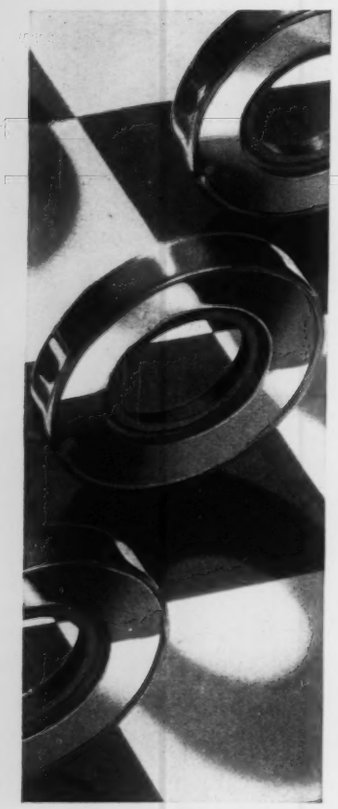
Link-Belt Chains and Wheels can be readily identified by this trade >———< mark.

This new 264 page Link-Belt Roller Chain Data Book No. 1457 is the most comprehensive roller chain catalog and engineering data book we have ever published.

LINK-BELT COMPANY
Leading Manufacturers of Positive Power Transmitting Equipment
519 N. Holmes Avenue, Indianapolis, Ind.
Offices in All Principal Cities 4637

SEAL YOUR BEARINGS *with* PERFECT OIL RETAINERS

FOR THIS DOUBLE-ACTING PROTECTION



The Perfect Oil Retainer is the cumulative result of more than half a century's experience by the world's largest processor of leathers for industrial use. The scientific spring design is the most efficient for its purpose that highly skilled engineers can devise.

The combination of this specially tanned and treated leather with the perfected coil spring provides an oil seal that will efficiently seal all lubricants by applying a light, but *uniform,* positive pressure of the packing on the shaft, and at the same time exclude dust, dirt, grit and all other abrasives from the bearings.

The leather will not disintegrate and allow fibrous material to work into the bearings. It is not harmed by mineral lubricants—becomes soft and flexible when oiled to permit free rotation of the shaft. It is unusually wear resisting as evidenced by repeated tests under actual load conditions in which Perfect Oil Retainers have run more than a million revolutions without showing a sign of wear.

Nothing but a leather seal can give you *so much* protection for *so little* cost. Details about your product sent to us on the coupon below will bring you valuable information on the sealing of your lubricants and adding to the life of your bearings.

. . . FILL OUT AND MAIL THIS COUPON TO . . .

CHICAGO RAWHIDE MANUFACTURING CO.,
1304 ELSTON AVE., CHICAGO

Name of product_____ Shaft speed_____

Type of lubricant used_____ Shaft diameter_____

NAME_____ COMPANY_____

ADDRESS_____ CITY_____

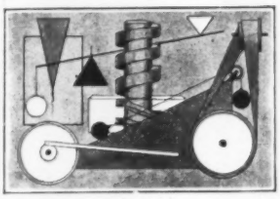
NEW YORK DETROIT CLEVELAND PHILADELPHIA PITTSBURGH

MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 December, 1932 Number 12



Forthcoming ISSUES

MOST engineers responsible for design have had actual shop experience. Others possess sufficient knowledge of shop practice to be able to visualize production difficulties. In all cases, however, unless close contact is maintained with manufacturing processes design is bound to suffer.

The new series of articles commencing with the leading contribution in this issue has been planned to assist the designer to polish up his knowledge of shop problems. Future articles will be as practical as the current one on founding.

L. E. Jermy

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Penton Publishing Co. Ltd., Caxton House, Westminster, London, S.W.1

Published on the tenth of each month. Subscription rates: U. S. and Possessions, two years $5; one year $3. Single copies, 35 cents. Canada, two years $6; one year $3.50, including duty. Europe, two years £2; one year £1.4.0.

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Seeing is Believing. Sample Free.

Ball bearings outlast plain bearings because they reduce wear considerably. Friction is eliminated almost entirely. And dirt, the worst enemy of any bearing, may be barred more effectively.

Until New Departure engineers introduced the revolutionary idea of seals integral with the bearing, each machine builder was compelled to make and install a multiplicity of small parts — a slow and expensive procedure.

No wonder the N-D-Seal gained instant popularity. The cutaway view tells you the story. Only the finest woven felt is used for seal material. Tearing is prevented by glass-smooth metal surfaces. The overhung shield makes a most effective protection against injury to bearing from foreign matter.

Each bearing is filled at the factory with sufficient and proper lubricant for several seasons of service.

Scores of instances can be cited in which N-D-Seals are performing with great success at speeds of ten thousand to thirty thousand r. p. m.

Send for a sample N-D-Seal and a booklet describing its many advantages. This offer is limited to engineers and executives who write on their company letterhead, telling where they read this ad. The New Department Mfg. Company, Bristol, Conn.; Detroit, Chicago.

NEW DEPARTURE BALL BEARINGS

NITE

Machine Design is as definite as its name. It is a definite publication, serving a very definite field. The function of Machine Design is that of a conveyor of ideas on design from one type of machinery manufacturer to all others. It carries the most advanced and authoritative information on methods, materials and parts.

Machine Design is not a medium for everything—but for Manufacturers of materials, parts and accessories which are designed into the machines of America—Machine Design has a definite, tangible value. We should like to tell you about this value—in terms of your product. We have helped others—some by advising against the use of Machine Design—some by showing how their product fits into the design function—to their ultimate profit.

May we tell you the whole story?

Machine Design is published by The Johnson Publishing Company, Penton Building, Cleveland, Ohio. Affiliated with The Penton Publishing Company.

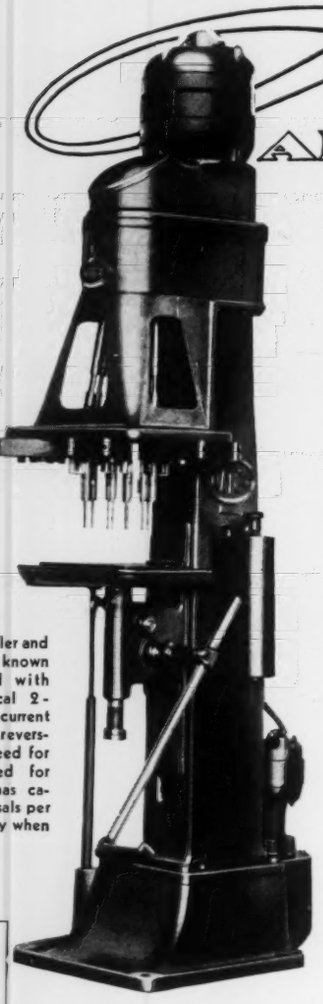
DESIGN

LOUIS ALLIS

Squirrel Cage REVERSING MOTOR

delivering

"MORE THAN HORSEPOWER"



New Multiple Driller and Tapper of well-known make, equipped with Louis Allis vertical 2-speed alternating current squirrel cage rapid reversing motor; high-speed for drilling; low-speed for tapping. Motor has capacity of 50 reversals per minute continuously when tapping.

Previous design of Multiple Driller and Tapper shown above. An ordinary motor was used. Consequently, belts, pulleys, a shifter clutch, and tripping mechanism were needed to reverse the spindles.

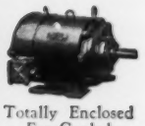
25 operating cycles per minute, the capacity of this new multiple driller and tapper, is machine performance extraordinary. And it took an extraordinary driving motor to make this possible.

Making 50 reversals per minute continuously, without over-heating, this Louis Allis 2-speed rapid reversing motor delivers more than "so much horsepower". It creates and improves machine performance . . . eliminating the belts, pulleys, shifter clutch, and tripping mechanism formerly used to reverse the spindles when tapping.

This illustrates how machine builders now are capitalizing the hidden advantages in correct motor design and precise application. For L.A. motors, designed for *definite results,* are delivering "More Than Horsepower" on all types of production machines.

Louis Allis engineers will gladly help *you* build better performance, appearance, and sales appeal into *your* product. Write for literature, and tell us your problem.

Pipe-Ventilated



Totally Enclosed Fan-Cooled

Explosion-Proof

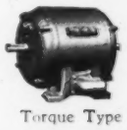
Wound-Rotor

Direct Current

Head-Stock Type

Vertical

Flange-Mounted



Torque Type

Standard Single or Multi-Speed

Self-Cleaning

Drip-Proof

Frame Type Shaftless

Rolled Shell Shaftless

Arbor Type

Hoist Type

SINCE 1901

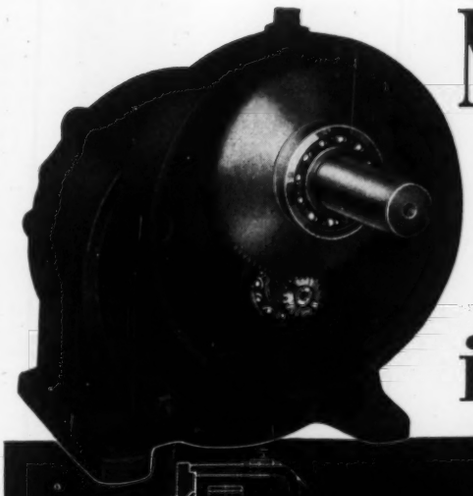
STANDARD AND CUSTOM BUILT MOTORS

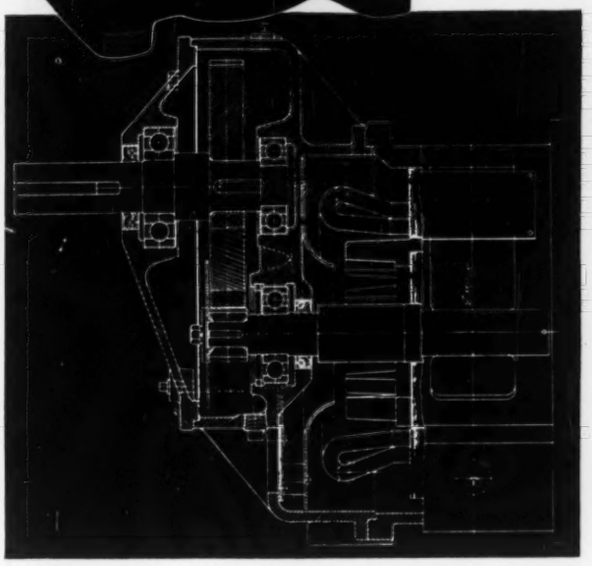
THE LOUIS ALLIS CO. MILWAUKEE, WIS.

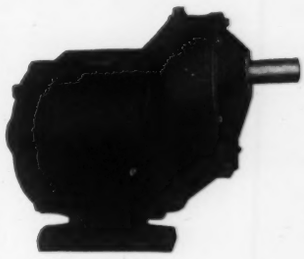
New Gearmotor-

the Dragon announces-

is Fafnir Equipped!







A new Westinghouse solution of the mechanical transmission problem is the gearmotor—a neat, highly efficient and inexpensive combination electric motor and speed reducer. Made in three types, for drives from ½ to 75 horse-power, and with ratios ranging up to 40 to 1, it can be readily seen that with customary thoroughness, Westinghouse has covered the field completely.*

This gearmotor is the culmination of 10 years' testing and experimentation. Thus the specification of Fafnir Ball Bearings is no empty honor. The selection of Fafnirs was influenced by the extra strength and capacity inherent in the large balls, deep races and high quality characteristics of this line. Required features of the new gearmotor are compactness, flexibility, simplicity, efficiency, quietness and low upkeep cost. Fafnir Ball Bearings assist to a great degree in obtaining these ends.

Fafnir has much to offer builders of every type of machinery. Able to choose from "the most complete line of types and sizes in America," the engineering staff in its recommendations can assure the selection of the bearing exactly suited to the job. The use of Fafnir facilities and Fafnir anti-friction experience will do much to make even the finest product better, more efficient, longer-lived. This service is yours for the asking.

**A recent issue of The Dragon told the complete story of the new Westinghouse Gearmotor and why it is Fafnir-equipped. Every issue has equally interesting ball bearing information. Would you like to be on our mailing list?*

THE FAFNIR BEARING COMPANY, New Britain, Conn.

Atlanta Chicago Cleveland Dallas Detroit
Los Angeles Milwaukee Newark New York Philadelphia

Fafnir·Ball·Bearings

Calendar of Meetings and Expositions

Dec. 14—Malleable Iron Research Institute. Annual meeting to be held at Cleveland. Robert E. Belt, Union Trust building, Cleveland, is secretary of the organization.

Jan. 7-14—National Automobile Show. Annual exhibition to be held at Grand Central Palace, New York.

Jan. 12—Society of Automotive Engineers. Annual dinner held by the society is scheduled for New York. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

Jan. 15—American Engineering council. Annual meeting to be held at Washington hotel, Washington. L. W. Wallace, 744 Jackson Place, Washington, is executive secretary of the council.

Jan. 16-21—Steel Founder's Society of America. To hold annual meeting at Detroit. G. P. Rogers, 932 Graybar building, New York, is managing director of the society.

Jan. 16-20—American Road Builders' association. Annual meeting and road show to be held in Detroit coincident with the Highway and Building congress and the meetings of twenty national associations. Road machinery and similar equipment will be displayed. Charles M. Upham, National Press building, Washington, is engineer-director of the road builders' association.

Jan. 20-28—National Power Boat Show. Annual exhibition sponsored by National Association of Engine and Boat Manufacturers will be held at Grand Central Palace, New York, and include power boats, engines, parts and accessories.

Jan. 23-25—American Society of Heating and Ventilating Engineers. Thirty-ninth annual meeting and exposition of equipment to be held at Hotel Gibson, Cincinnati, O. A. V. Hutchinson, 51 Madison avenue, New York, is secretary of the society.

Jan. 23-26—Society of Automotive Engineers. Annual meeting to be held at Book-Cadillac hotel, Detroit. John A. C. Warner, 29 West Thirty-Ninth street, New York, is secretary.

Jan. 23-27—American Institute of Electrical Engineers. Winter meeting of the society is to be held in New York. H. H. Henline, 33 West Thirty-Ninth street, New York, is acting national secretary of the society.

March 7-10—American Management association. Annual packaging, packing and shipping exposition to be held at Hotel Pennsylvainia, New York. Roberts Everetts associates, 225 West Thirty-fourth street, New York, are exposition managers.

March 7-10—Package Machinery Manufacturers. Meeting to be held in New York during annual packaging exposition. H. H. Leonard, Consolidated Packaging Machinery Corp., New York, is chairman of the meeting committee.

March 13-16—National Railway Appliance Exhibition. To be held at Chicago. C. W. Kelly, 1014 South Michigan avenue, Chicago, is manager of the exhibition.

March 15-17—American Railway Engineering association. Annual meeting to be held in Chicago. E. H. Fritch, 59 East Van Buren street, Chicago, is secretary of the association.

March 26-April 1—American Chemical society. Eighty-fifth meeting to be held at Washington. Dr. Charles L. Parsons, 728 Mills building, Washington, is secretary of the society.

April 26-28—American Welding society. Annual meeting to be held in Engineering Societies building, New York. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary of the society.

May 11-13—Electrochemical society. Spring meeting to be held at Montreal, Que., Dr. Colin G. Fink, Columbia university, New York, is secretary of the society.

June 11-16—American Oil Burner association. Tenth annual meeting and exposition of equipment to be held at Hotel Stevens, Chicago. Harry F. Tapp, 342 Madison avenue, Chicago, is secretary of the association.

June 12-15—National Association of Purchasing Agents. Exposition and annual meeting to be held at Hotel Statler, Boston. G. A. Renard, 11 Park Place, New York, is secretary of the association.

June 19-22—American Foundrymen's association. To hold annual meeting and exhibition of equipment at Hotel Stevens, Chicago. C. E. Hoyt, 222 West Adams street, Chicago, is secretary of the association.

Drawing Board Conferences gain these savings in Motor Control . . .

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ENGINEERS who design the machines which cut the costs of Industry no longer need to be told the advantages of incorporating Motor Control as an integral part of their product.

Such engineers realize that only by building the proper control into their designs can they be certain their customers will secure all the cost-saving advantages of the new machines.

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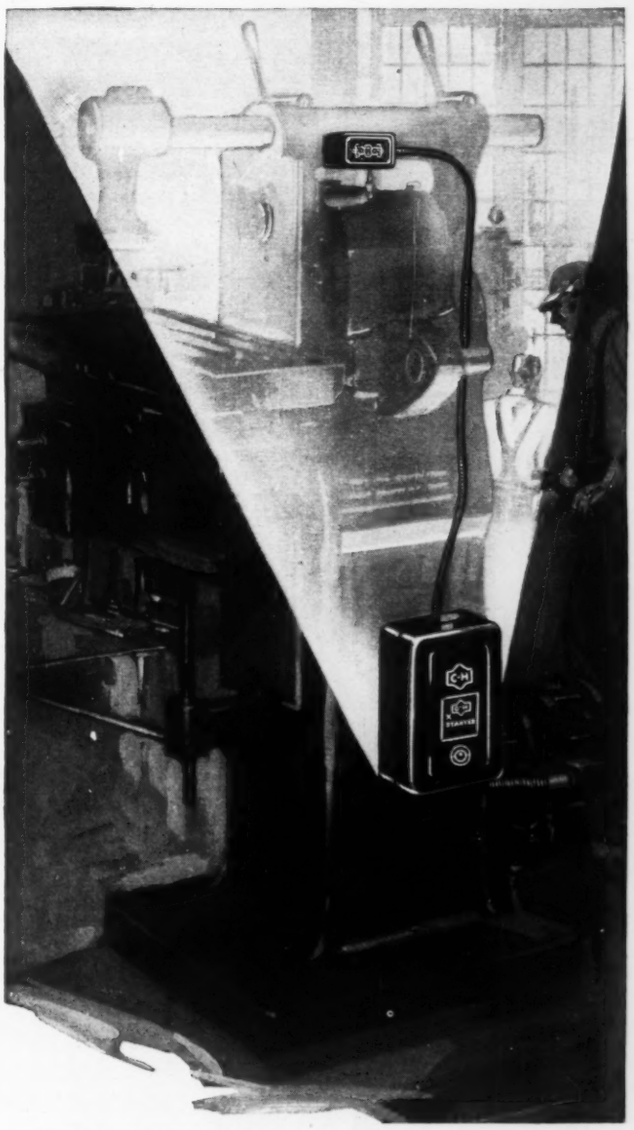

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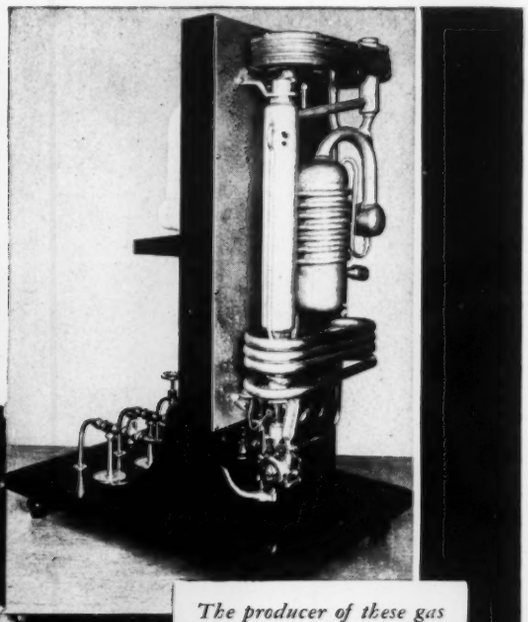

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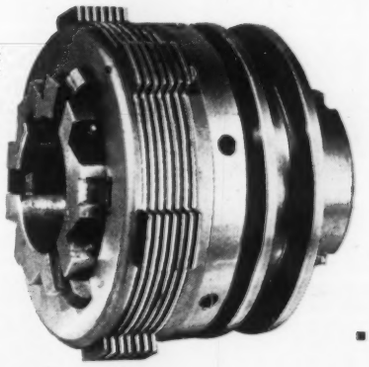

. . . . "BECAUSE WE COULD BUY THEM CHEAPER THAN WE COULD BUILD THEM"

. . . that's what the makers of the Baird Automatic Lathe have to say about the *cost economy* of Twin Disc Clutches. Their many *performance economies*—the fact that Twin Disc Machine Tool Clutches combine compactness with capacity, adaptability with accessibility, to give easier, more positive control while assuring speedier and greater production — is another story.

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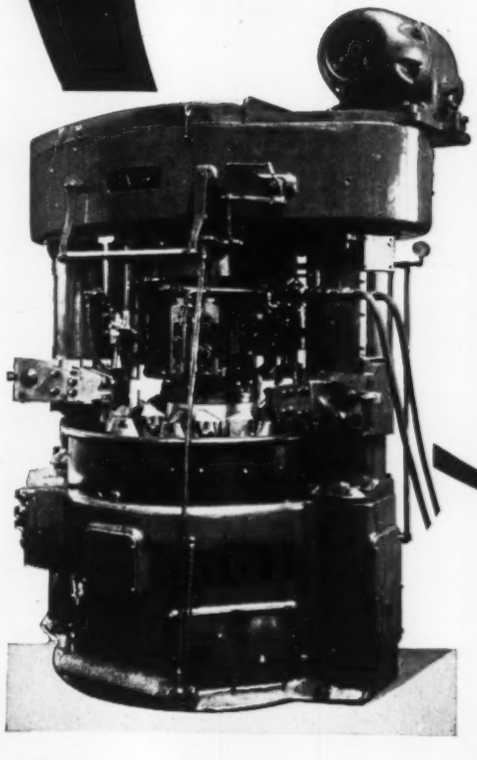

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The propelling force in man . . . that urge to improve what he has already done well . . . is, in the words of Plato, a "divine discontent."

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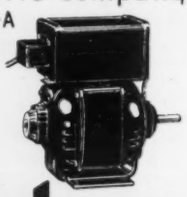

Leland Motors

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MACHINE DESIGN
is a monthly technical publication conceived, edited and directed expressly for those executives and engineers responsible for the creation and improvement of machines built for sale, and for the selection of the materials and parts to be used.

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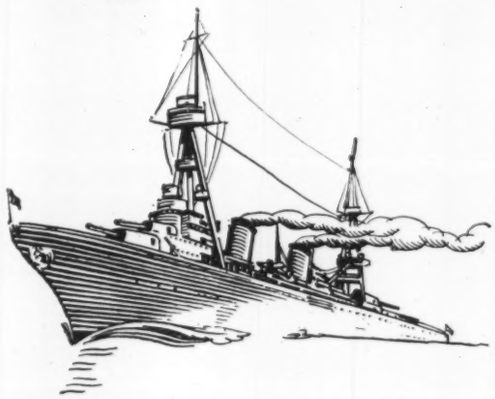

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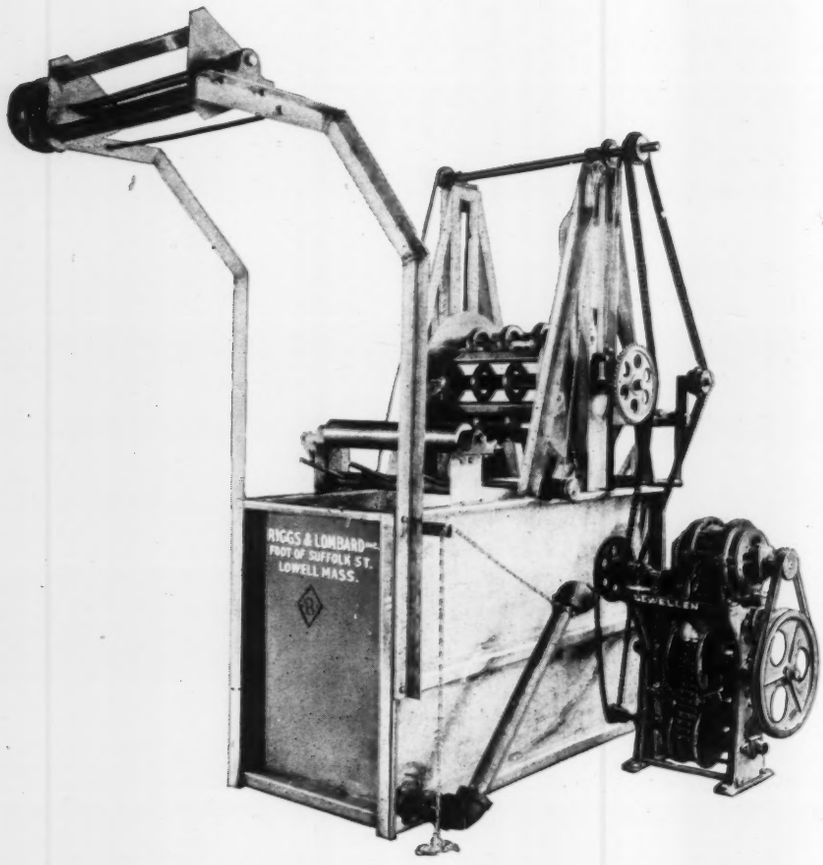

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Instead of having various size Sample Dye Kettles, for different kinds and yardages of cloth, this Universal Sample Dye Kettle may be used for any length of sample from 2 to 45 yards. The Lewellen Transmission incorporated in the drive, makes possible any reel speed from 4 to 40, making this machine easily and quickly adaptable to approximately 100% of a mill's sample requirements.

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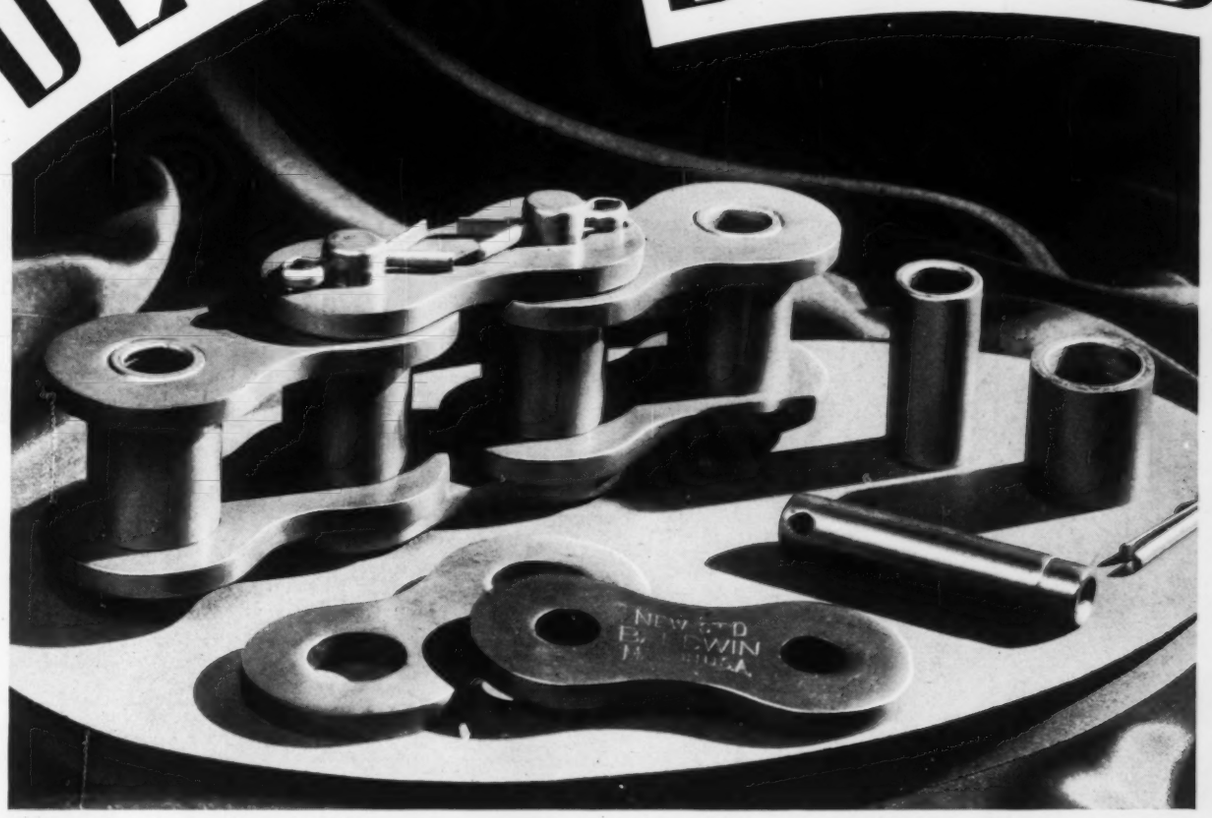

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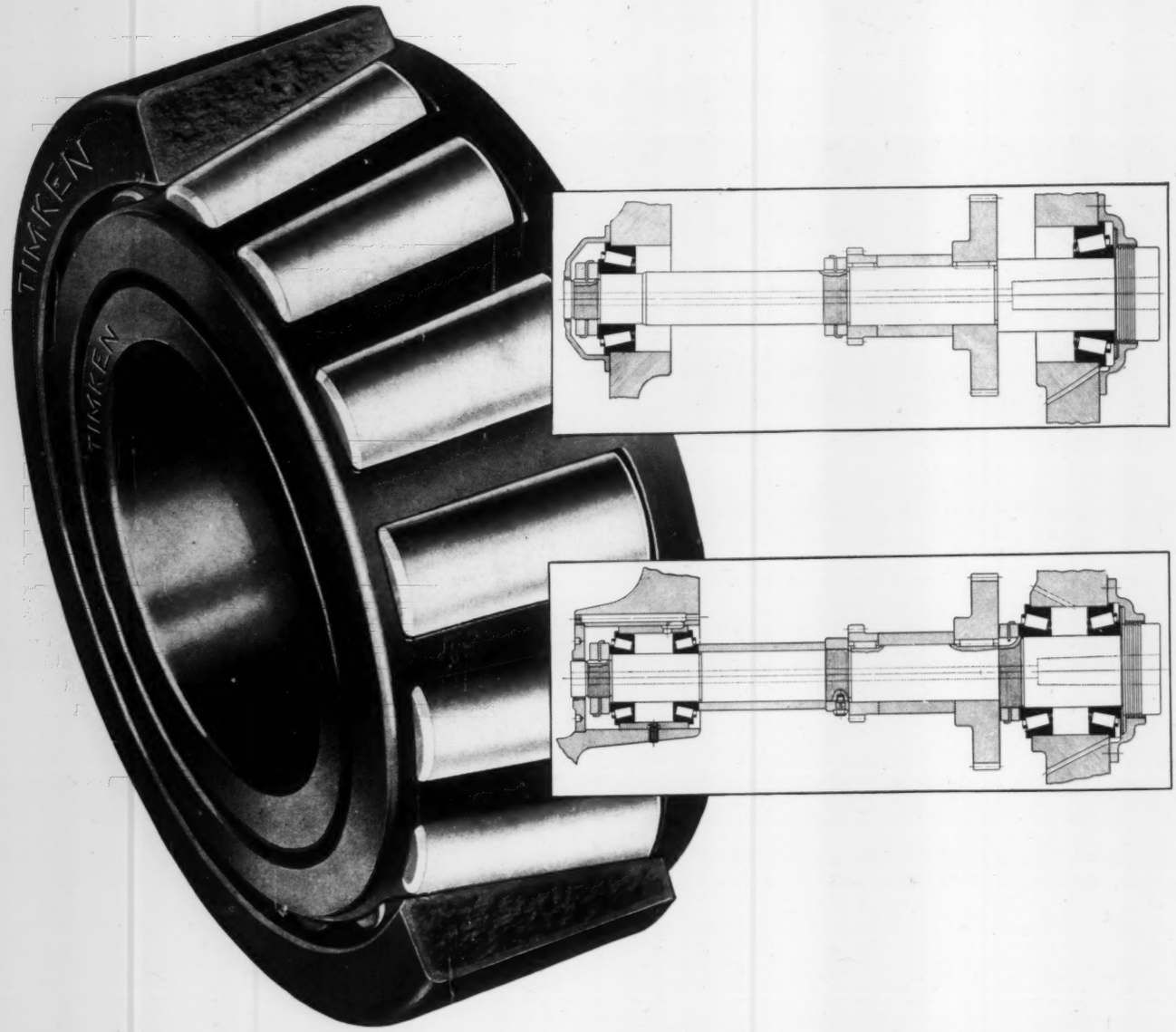

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